Comparative Engineering Costing and Implications of Commercial and Smallholder Irrigator Design for Projects

by

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ABSTRACT

In the study, six irrigation schemes based in the Eastern Cape have been considered and evaluated, according to two levels of supply (LOS) of irrigation water. The two levels of supply are that of a commercial irrigator and that of a smallholder irrigator. The irrigation infrastructure for each of the six schemes was designed, and the associated costs determined, for each level of supply.

The primary objective of the study is to determine the impact of infrastructure costs and irrigation areas on the target user, either the commercial or the smallholder irrigator. This is related directly to the assumption that lower water volumes are used by the smallholder irrigator.

The study addresses the impact of different designs on the amount of water used, land utilised and resultant costs of the infrastructure.

The initial capital costs and the on-going operational and maintenance costs (O&M) for each level of supply for each of the schemes have been calculated. The evaluation of the two LOS has shown that the capital cost for the commercial LOS is approximately 18 % higher than for the smallholder LOS and the O&M costs 6 % to 36 % higher.

The schemes that were investigated can be grouped into five general scheme types. The first type is gravity schemes, which need rehabilitation, while the bulk supply is in place with no augmentation or rehabilitation required. The second is pumped scheme which is in need of rehabilitation, while the bulk supply is in place with no augmentation or rehabilitation required. The third type includes run-of-river schemes where water is abstracted and pumped directly to the lands. The fourth type includes run-of-river schemes where water is abstracted and pumped to storage. The fifth type is the gravity scheme where the bulk supply needs to be installed as part of the scheme. These types are then grouped and can be used to give guidance on the anticipated costs dependant on the scheme type and the required level of service (Table 1).

Table 1: Indicative cost of irrigation schemes

Scheme Type	Commercial LOS			Smallholder LOS		
	Capital cost, (R /ha)	**O&M (R/ha)**	**Annual cost of water (R/m^3)**	**Capital cost, (R / ha)**	**O&M (R/ha)**	**Annual cost of water (R/m^3)**
Gravity - rehabilitation	33,397	213	0.03	23,485	150	0.03
Pumped – rehabilitation	44,027	2,527	0.30	42,433	2,156	0.36
Run of river - pumped to field	80,089	2,811	0.64	72,352	2,209	0.72
Run of river - pumped to storage	126,877	11,734	1.60	108,704	7,553	1.47
Gravity with bulk supply	163,874 - 155,888	2,503 - 634	0.29 - 0.08	136,886 - 103,488	2,344 - 441	0.38 - 0.08

A further objective of the research is to determine the impact on the smallholder irrigators who find themselves on a commercial LOS system. This can be either on a scheme that has already been designed, or on a new system.

The evaluation of the commercial under-utilised LOS and the smallholder LOS has shown that the commercial capital cost is 18 % higher and the O&M costs 5 % to 29 % higher.

The study further aligns the estimated costs with the farmer typology providing a broader understanding of the design to be adopted for different levels of supply. This provides the linkage between farmer types, the design to be implemented and the anticipated costs thereof.

OPSOMMING

As deel van hierdie narvorsing word ses verskillende besproeiingsskemas in die Oos-Kaap ten opsigte van twee voorsieningsvlakke ondersoek . Die twee voorsieningsvlakke ter sprake is vir ‘n kommersiële en kleinboerdery opset. Die besproeiingsinfrastruktuur is vir elk van die ses besproeiingsskemas ontwerp en ‘n kosteberaming vir elk van voorsieningsvlakke gedoen.

Die hoofdoelwit van hierdie verslag is om te bepaal wat die impak van kostes en besproeiingsareas op beide kommersiële- en kleinboerderye is. Dit is direk gebaseer op die aanname dat kleinboerderye minder water gebruik.

Die verslag ondersoek die impak van verskillende ontwerpe op waterverbruik, besproeiingsoppervlak benodig en die gevolglike infrastruktuurkostes.

Die aanvanklike kapitaalkostes asook bedryfs- en onderhoudsuitgawes (B&O) vir elk van die voorsieningsvlakke, is vir elk van die besproeiingskemas bereken. Die resultaat van die ondersoek van die twee voorsieningsvlakke het aangetoon dat die kapitaalkoste van kommersiële besproeiingskemas 18 % hoër as die van kleinboerderye is, en bedryfs- en onderhoudsuitgawes 6 tot 36 % hoër.

Die skemas wat ondersoek is, kan in vyf algemene skema tipes verdeel word. Die eerste is die gravitasieskemas wat rehabilitasie benodig terwyl die hooftoevoer in plek is met geen uitbreidings- of rehabilitasiebehoeftes. Die tweede is pompskemas wat rehabilitasie benodig terwyl die hooftoevoer in plek is met geen uitbreidings- of rehabilitasiebehoeftes. Die derde is rivierskemas waar besproeiingswater direk uit die rivier na die landerye gepomp word. Die vierde is rivierskemas waar besproeiingswater direk uit die rivier na a reservoir gepomp word. Die vyfde skema tipe is die gravitasieskemas waar die hooftoevoer ook gebou moet word as deel van die skema. Die skema tipes kan gebruik word om leiding te verskaf ten opsigte van verwagte skema kostes afhangende van die skema tipe en vereiste voorsieningsvlak (Tabel 1).

Tabel 1: Verwagte kostes van besproeiingskemas

Tipe Skema	Kommersiële Voorsieningsvlak			Klein boerdery voorsieningsvlak		
	Kapitale koste, (Rx10^3/ha)	**B&O (R/ha)**	**Jaarlikse waterkostes (R/m^3)**	**Kapitale koste, (Rx10^3/ha)**	**B&O (R/ha)**	**Jaarlikse waterkostes (R/m^3)**
Gravitasie - rehabilitasie	33,397	213	0.03	23,485	150	0.03
Pomp na landerye – rehabilitasie	44,027	2,527	0.30	42,433	2,156	0.36
Rivier – pomp na landerye	80,089	2,811	0.64	72,352	2,209	0.72
Rivier – pomp na reservaar	126,877	11,734	1.60	108,704	7,553	1.47
Gravitasie met hooftoevoer	163,874 - 155,888	2,503 - 634	0.29 - 0.08	136,886 - 103,488	2,344 - 441	0.38 - 0.08

‘n Verdere doelwit van die studie is om die impak op kleinboere te bepaal wat op ‘n kommeriële voorsieningsvlak boer. So ‘n stelsel kan ‘n gevestigde of nuwe stelsel wees.

Die resultaat van die ondersoek van die onderbenutte kommersiële voorsieningsvlak en die kleinboerdery voorsieningsvlak het gewys dat die kapitaalkoste van kommersiële besproeiingskemas 18 % hoër as die van kleinboerderye is, en bedryfs- en onderhoudsuitgawes 5 tot 29 % hoër.

Die verslag vereenselwig die verwagte kostes met die tipe boerdery en verskaf ‘n beter begrip van die tipe ontwerp wat elk van die voorsieningsvlakke benodig. Dit verskaf dus die verband tussen die tipe boerdery, die ontwerp benodig en die verwagte projekkostes.

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Firstly and most importantly, to my Lord and Saviour, Jesus, without whom I would not be in a position either to have started or completed the project.

I would like to thank those at Arcus Gibb for their support and assistance. Special thanks must be paid to Dave Clark for his assistance during the process.

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LIST OF ABBREVIATIONS

BEWAB	Besproeiingswater Bestuursprogram
CROPWAT	Computer program
COMBUD	Computerised Enterprise Budgets
DI	Ductile Iron
DoA	Department of Agriculture
DWA	Department of Water Affairs
ETo	Reference evapo-transpiration
GEAR	Growth, Employment and Redistribution
GRP	Glass Fibre Reinforced Polyester
FAO	Food and Agriculture Organization
FSA	Full Supply Area
FSC	Full Supply Capacities
GDP	Gross Domestic Product
Ha	Hectare
HDPE	High density polyethylene
ICON	Iterative-Consultative Approach
IMT	Irrigation Management Transfer
IFR	In-stream Flow Requirement
km	Kilometre
KSD	King Sabata Dalindyebo
l/s	litres per second
LDPE	Low density polyethylene
LM	Local Municipality
LOS	Level of Supply
MAR	Mean annual runoff
NPV	Net present value
MPVC	Modified Polyvinyl Chloride
m/s	metre per second
m^3	cubic metre
m	metre
O&M	Operations and Maintenance
PAWC	Profile Available Water Capacity
PRA	Participatory Rural Appraisal
RAAKS	Rapid Appraisal of Agricultural Knowledge Systems
RDP	Reconstruction and Development Programme

RESIS	Revitalisation of Smallholder Irrigation Schemes
WR90	Water Resources of South Africa (1990) study
WSP	Water Service Provider
WUA	Water Users Association
SAPFACT	Computer routine for interviews and inspections
SAPWAT	A computer program for the calculation of crop water requirements

1 INTRODUCTION

Much discussion and debate has occurred along with the on-going government spending on the irrigation sector of agri-industry. The government focus has been specifically targeted at smallholder irrigators, seeking to provide much-needed assistance to them.

Specific programmes such as the Revitalisation of Smallholder Irrigation Schemes (RESIS) in the Limpopo Province and other, mostly *ad hoc* developments, on a project-by-project level led by general policy have taken place over the last few years. The Department of Water Affairs (DWA) has developed a policy for the financial assistance of poor farmers (DWAF, 2004). These poor farmers fall mainly into the category of smallholder irrigators.

The perception is often held that irrigation holds the keys to poverty alleviation, especially in the rural areas. Politics holds a key aspect to the development of smallholder irrigators as the provision to rural communities of irrigation aligns directly to national poverty alleviation goals. Hence, considerable emphasis on smallholder irrigation and on budgets allocated for the express purpose of developing smallholder irrigators has taken place.

Limited national resources require that the best use is made of these budgets, and one of the primary aspects is the cost of infrastructure development. With the correct design philosophy and by optimising the system design, the project life cycle costs can be minimised.

When designing a new scheme, or considering one due for revitalisation, particular aspects which will influence the design and profitability of the project should be considered, as these will influence the design approach. These considerations are usually centred on designing for a commercially based operation, or on altering the design to cater specifically for the methods of operation of the smallholder irrigator. This research aims to provide some guidance on the cost ranges that can be expected, and what approach should be adopted under each particular circumstance.

2 OBJECTIVE OF RESEARCH

2.1 Motivation for direction of research

The current context of the South African irrigation is that there are two primary fields of design approach. The first approach is that for commercial farmers and the second approach for the smallholder irrigators who generally have access to smaller portions of land and finance. The smallholder irrigator generally produces reduced crop yields compared to that of a commercial irrigator. The smallholder will theoretically therefore use less water to produce the reduced yield.

It must be considered whether it is viable to design the system that a smallholder irrigator will be utilising on the demands that will be applicable to their actual water use. This consideration may result in lower initial capital costs when installing the system.

With the current funding by the South African Government of smallholder irrigator schemes, it is important to determine the best practice regarding these scheme designs. The impact of reduced demands needs to be considered as this may result in reduced capital costs of implementation, which can lead to excess funds that may be used more efficiently, either in the mentorship of the farmer, or even for the implementation of additional schemes.

If the system is over-designed, there will be redundancy in the system. In addition, the greater size of varying infrastructure components will have an adverse impact on maintenance and future replacement costs.

2.2 Research question

A smallholder irrigator will be significantly more dependent on the designers to guide him on the use of the system than a commercial farmer will. The design approach will be different to that adopted for a commercial farmer.

It is therefore important to identify all the possible design parameters. Reduced yields, reduced water demand and how these can affect the design should, therefore, be investigated thoroughly.

Feasibility studies provide good opportunities to investigate a number of options and variations on management procedures. During the investigation process, the interviews with the prospective farmers will give direction on the design process. Further, the probable post-implementation support levels needed, will also have a significant impact on the design. During implementation, the design will need to incorporate the skill levels of the farmer and these will be significantly different without long-term support.

In the provinces of South Africa, different implementation strategies are being adopted by the Government departments. The objective of this research is to direct the efforts so that the most suitable solution is implemented.

The primary objective of the study is to determine the impact on infrastructure costs and irrigation areas on the target user, be they either a commercial or a smallholder irrigator. The possible impact on costs over the area that can be irrigated, assuming that lower water volumes are used, is not accurately known and is beyond the scope of this research. This could however be directly related to the percentage reduction of water usage and may prove a fruitful area for a future research topic.

It is anticipated that the relationship between development costs and water use is complex. The scale of development has a direct impact on the end costs and economy of scale. This can result in higher costs overall, but lower costs per hectare or per cubic metre of water.

Each scheme will be evaluated on the two primary end user types: namely a commercial and a smallholder irrigator. This will allow for the calculation of development costs for each scheme for both irrigator types. The comparison of the costs for each design under the same constraints can then be made, and the merits of the design for each can be determined.

It is expected that a commercial solution will have a higher development cost. This is understandable, as the design will need to accommodate a larger water demand. The designs will therefore be compared on a cost per cubic metre of water, which will give a better indication of the cost effectiveness between the designs.

The purpose of the investigation is to compare the impact of designing for a commercial operation with that of smallholder irrigators. The smallholder will achieve lower yields, since they generally plant at a lower density.

The different design approaches can be assessed on the impact of the amount of water used, the land utilised and the infrastructure costs according to the irrigator.

2.3 Role in underlying feasibility study

The basis of the research done to address the relevant research question was a Feasibility Study completed by Arcus Gibb (2004a-f). The information provided in the Gibb report was used to calculate the necessary water requirements and resulting engineering costs of the two options compared in the research.

3 LITERATURE REVIEW

3.1 History of development of smallholder irrigation in South Africa

3.1.1 Introduction

South Africa is a country with dry climatic conditions where there are regular water deficits. This makes irrigation a necessary option to reach optimum crop yields. The general development has been outlined by Bruwer and Van Heerden (1995) and summarised below.

Irrigation was first introduced in 1652 with small-scale irrigation projects forming the primary form of development. During the period 1912 to 1930, irrigation development was more co-ordinated, resulting in large irrigation projects being developed.

From 1930 to 1960, the schemes developed were canal irrigation schemes. The irrigation efficiency of these schemes was low and usually less than 50%. This was primarily due to low skills level, relatively old age of the farmers and poor irrigation design. The design usually ignored soil properties, resulting into under-irrigation in some areas and waterlogging in others. There were further problems with the estimate of the availability of water. Many farmers left their schemes, selling to new farmers or to existing farmers, who subsequently consolidated their holdings.

From 1970, the experience gained from these schemes was used in the planning of further schemes. Water availability was given greater consideration and resulted in inter-basin transfers. There were efforts to target younger farmers with higher levels of education. Research has resulted in greater knowledge on irrigation scheduling becoming available that has been passed on to the farmers. There has been a move to encourage farmers to move from surface to overhead irrigation, aimed specifically at more profitable crop markets.

3.1.2 Irrigation development in the former "Homelands"

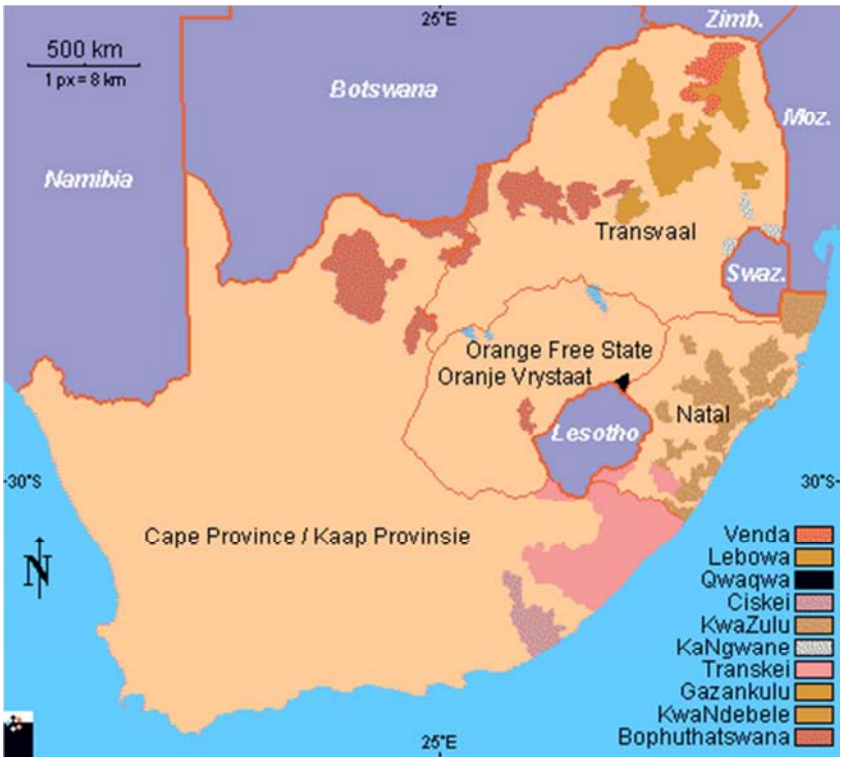
Irrigation development in the former "Homelands", as outlined by Van Averbeke *et al.*, (1998), started in 1955. In 1955 11,400 ha was farmed by 7,538 plot holders.

The initial plot sizes were recommended by the Tomlinson Commission to be 1.3 ha to 1.7 ha. This was suggested to be suitable to provide for a family. Based on the estimated 54 000 ha available to black people and the recommended plot size, some 36 000 families could be settled on the schemes.

During the 1950's and 1960's, the design of schemes primarily followed the Tomlinson Commission guidelines. The guidelines recommended the use of an inexpensive design such as furrows and surface irrigation. Examples include schemes such as Qamata, Cata and Upper Gxulu in the Eastern Cape.

From the 1970's, the focus on scheme development altered to become more technically sophisticated with a high capital requirement. In the (former) Transkei and Ciskei (shown in Figure 3-1), consultants Loxton & Venn were used as the implementing agents. The schemes were designed to be run in two operations. The operations consisted of a commercial and a subsistence section, where the commercial segment offered the economic benefits, and the subsistence segment offered the social benefits. The land split was approximately 75 % commercial and 25 % subsistence. The land from the communities was then included in the scheme. Where possible, the incorporation of the land was done using land rentals or leases.

Figure 3-1: Former boundaries of South Africa



http://www.fotw.net/misc/za(old.gif

3.1.3 Developments on irrigation schemes in the Eastern Cape

The schemes developed in the ‘Homelands’ of the Eastern Cape were generally successful, but profits deteriorated over time requiring greater and greater subsidies as outlined by Van Averbeke *et al*. (1998). These subsidies were necessitated by issues around labour rights and higher wage levels, which led to reduced profitability. As profits dropped and benefits to the farmers reduced, the farmers reclaimed the land. Reclaiming the land further reduced production as the reclaimed land was generally left idle. The managing agents were removed in the late 1980’s and early 1990’s. The farmers, used to the support from the managing agents, were unable to support themselves. The schemes then fell under the parastatal organisations, Tracor and Ulimocor. The profitability of the schemes continued to suffer. This lack of profitability was exacerbated by the guarantee of state jobs until 1999. After this date, there were many redundant workers on the schemes, the costs of which were borne by government.

3.1.4 Irrigation management transfer (IMT) and revitalisation

The most recent stage of smallholder irrigation in South Africa can be referred to as the irrigation management transfer and revitalisation era (Van Averbeke, 2007). This coincided with the political change in the country and the ideologies that it brought. This was first pursued through the Reconstruction and Development Programme (RDP), and was focussed on food security, resulting in the development of smaller schemes. The RDP was superseded by Growth, Employment and Redistribution (GEAR) Policy where the strategy shifted to one of poverty eradication. Existing schemes were targeted, but these needed, firstly, to be revitalised. Part of the process was the transfer of the responsibility of managing, operating and maintaining the irrigation scheme. This process is known as Irrigation Management Transfer (IMT).

Since 1995, revitalisation of irrigation schemes has become more prevalent, especially as more and more schemes were becoming dysfunctional. Backeberg (2004) illustrates that there is now a government policy regarding revitalisation with requirements set by the Department of Agriculture (Department of Agriculture, 2002). With the current focus on revitalisation, the process must learn from previous development mistakes. The previous focus on infrastructure at the expense of social relations, land tenure, water entitlements, economic location and market access, financial capital and support services, technical and financial viability, and resources of households, will result in simply repeating the mistakes of previous generations.

One of the most comprehensive initiatives is the Revitalisation of Smallholder Irrigation Schemes (RESIS) in the Limpopo Province (Arcus Gibb, 2005). The programme involved the Water Care programme and involved the revitalisation of the schemes' infrastructure, leadership, management and productivity.

A summary of the existing schemes in South Africa (Denison, 2006) and the characteristics of when they fit in the development history are shown as Table 3-1.

Table 3-1: Categorisation of existing smallholder irrigation scheme development

Era	No of schemes	Area (ha)	Mean area per scheme (ha)	Main technology used
Smallholder canal scheme (1930-1969)	74	18,226	246	Gravity-fed surface irrigation
Independent homeland (1970-1990)	62	12,994	210	Different forms of overhead irrigation
IMT and revitalisation (1990-present)	64	2,383	37	Pump and sprinklers or micro-irrigation
Year of establishment uncertain	117	15,897	136	Mostly overhead irrigation
Total	**317**	**49,505**	**156**	

Revitalisation is differentiated from rehabilitation in that it is not only concentrated on the engineering aspect of the schemes. Denison (2005) identifies that a holistic approach is rather taken where human development, individually and organisationally, empowerment, access to information, marketing and business strategy development are emphasised together with the engineering aspects.

3.1.5 Impacts of historical development on the revitalisation process

The previous parastatal organisations managed the schemes in a top-down approach (De Langa *et al*., 2002). The smallholders were required to weed the land, harvest the crops and move the irrigation pipes. They made no decisions relating to the farm nor did they provide any capital. They, however, shared the risk of the crop yield. The operations and maintenance costs were fully subsidised. The plot holders were neither farmers nor wage labourers. Only the amounts left after expenses were distributed to them. There was no entrepreneurial aspect. Bembridge (1999) noted, "Scheme managers have been attempting to 'manage' farmers rather than encouraging entrepreneurial development". De Langa *et al*. (2001) showed that with the withdrawal of the parastatal, the scheme structure was removed and the organisations collapsed.

Particular items hindering smallholders were:

- The schemes were highly mechanised. With the withdrawal of the parastatal, so too was the equipment removed. The costs to hire replacement equipment were high resulting in lower returns;
- The support structures were lacking. Difficulties in acquiring inputs at reasonable prices and of getting produce to markets impacted on the farmer;
- With no formal land tenure, the fear of losing the land was high. In addition, no capital was available without formal ownership;
- Land size was also a major obstacle as it is not generally economically viable to support just one household. A dual approach is thus needed, in that the man works in town and the woman tends to the land. The land is also kept as security rather than as a tool to generate income; and
- Pumped schemes are initially cheaper in terms of capital costs, but are more expensive to run than gravity schemes. They, however, need a higher level of management than gravity schemes. The O&M costs have been observed worldwide to be about 5 % of the gross income from farming. However, in Africa, scheme costs are much higher and run at about 20 % - 25 % of the gross income. This makes for an immediate disadvantage and it was considered likely by De Langa *et al*. (2001) that these schemes would fail in due course.

De Langa *et al*. (2001) identified that the apparent total failure of the schemes in the Northern Province was attributed to the following:

- Total dependence on outside stakeholders;
- Water supply infrastructure dilapidated;
- Ineffective water management;
- Low production levels;
- Little knowledge of crop production or irrigation;
- Ineffective extension;
- Lack of markets and credit;
- Difficulty in sourcing inputs;

- Expensive and ineffective mechanisation services;
- Unrepaired fencing; and
- Damaged soils.

Commercial farmers, however, generally have adequate farms size, the resources and the management capacity to run their farms, but these are all seriously lacking for smallholders.

3.2 Characteristics of smallholder irrigation in South Africa

3.2.1 Introduction

Smallholder irrigation farmers in South Africa can be categorised in terms of their water supply as follows:

- Farmers on irrigation schemes;
- Vegetable gardeners; and
- Independent farmers, each with their own water supply

Existing schemes have a wide range of irrigation systems in operation. These include the following systems:

- Flood;
- Sprinkler;
- Centre pivot;
- Micro; and
- Drip irrigation

The study by Denison (2004a) identified that the most common type of irrigation infield system is sprinkler irrigation and this commands approximately 55 % of total area under irrigation. Flood irrigation makes up 34 % while pivots and drip/micro systems provide the remaining 11 %.

There are two primary management systems evident on smallholder irrigation schemes. These two systems can be categorised as follows:

- Externally managed, where a management team has total or predominant say in how the scheme is to be managed, and where the individual farmers have little or no say in decisions; or
- Internally managed, where the farmers make the decisions for the scheme and for the individual farm.

(a) External management

According to Crosby (2000), there is growing evidence that the success and ownership of an irrigation scheme by farmers is primarily dependent on the management system of the scheme. The externally managed schemes tend to have farmers that are dissatisfied. This is often despite the efforts of the management or developers to make the scheme a success. This is due to a lack of ownership of the scheme by the farmers, as the farmers have had no involvement in the decision making process of negotiating items such as crops, production and marketing. If the farmers have no input to the scheme, they are effectively just labourers used on the scheme. Only once they have active involvement in the scheme, do irrigation schemes become more successful.

Some of the difficulties that externally managed schemes face are:

- Lack of ownership;
- Distrust due to lack of financial awareness and no input on cultivation practice, ploughing, planting, spraying and marketing;
- Net farm income is usually low due to high overhead costs of management;
- Shared water sources require well-organised co-operation; and
- Large capital repayment costs and ongoing O&M costs are difficult to cover from financial returns, resulting in greater levels of indebtedness.

(b) Internal management

On the other side of the spectrum is the independent farmer. Crosby *et al.* (2000) identified farmers not involved in an irrigation scheme or garden group as independent. They will have their own water supply that is often a river or borehole. Since these farmers are not on irrigation schemes, they usually have chosen farming as a source of income. There are instances where independent farmers are shopkeepers or entrepreneurs in another business. The irrigation is used as an extra dimension either for the business or simply to supplement income. Since the farming operation is independent of a scheme, the irrigation systems have been installed using their own funds or family capital. The farms can encompass a wide range of establishments from vegetable plots to commercial units, often developed over a period.

Characteristics of independent farmer schemes are:

- Complete control over farming systems;
- The farmers rely on their own skills and have to make a profit to remain sustainable;
- Support services such as crop production, technical advice and even infrastructure advice are critical to production;
- Difficulty obtaining inputs such as seed, fertiliser and pesticides;
- Maintenance support is not usually available;
- Generic pumps are usually selected from a catalogue and used for irrigation; and
- Electrical supply to rural areas may be erratic and there may not be a supply at all, thus requiring the use of diesel-powered engines.

3.2.2 Issues found in smallholder irrigation

The type of system employed as an irrigation scheme is dependent on a number of parameters, and upon how easily they can be managed. These parameters are:

- Distance to the lands;
- The priority of irrigating to the farmers; and
- The size of the business.

The system needs to match the time constraints of the farmer. Crosby *et al*. (2000) identify the following two examples. A short-furrow system, that allows a farmer to spend time during the day where he is able to complete all the irrigation and maintain items on the plot, may be more suitable. In other circumstances, a farmer with a large plot might find short-furrow irrigation far too management intensive. This type of irrigation system would require too much time in the daily management of the system. This would detract from other farm issues such as marketing, maintenance and financial matters. A farmer would prefer a system that requires his attention for short periods during the day rather than be committed for the full day.

Every system installation should be based on the specific circumstances that are found in that situation. Some of the items that will need to be covered are:

- Availability of infrastructure for installation and ongoing maintenance;
- Availability of support services for maintenance of specialist equipment;
- Affordability and net positive returns;
- The type of soil and selection of the correct system to prevent either crusting or waterlogging;
- Appropriate systems such as short-furrows; and
- Other “fatal flaws” that need to be addressed to ensure success.

3.2.3 Infrastructure limitations to smallholder irrigators

A farmer’s productivity was found by Fan and Zhang (2004) to be affected by both education and infrastructure. As inputs and markets become more accessible, Kamara (2004) found the rural farmer will be able to become more productive. Nieuwoudt and Groenewald (2003) identified poor road conditions, high transport costs and distant markets which prevent good market access for smallholder irrigators.

Access to general basic services, such as banks and post offices, further affects the effectiveness of the smallholder irrigator. The access to general services may, at times, be done during visits to co-operatives and agricultural extension offices. The access to these general services has a direct bearing on their ability to access inputs, and markets. What are seen as simple services must not be ignored in the process of revitalisation (Chaminuka *et al*., 2008). Perret (2003) indicates that a lack of access may prove to be a limitation for farmers to take up any new or better technology.

3.2.4 Limited irrigation and crop water requirements

An important observation by Crosby *et al*. (2000) of smallholder irrigators is that they apply less water when compared to commercial examples. The actual water use, which is a result of lower plant densities and low input, needs to be determined. A system that delivers less water will be less expensive. This may be the difference between the farmer implementing the system or falling short with his finances. Where a farmer requires less water, the larger flow system may result in the system not being used to its full potential or to over-irrigation.

During the design of the system, the future needs of the farmer must be determined. The system can then be designed to allow flexibility in the operation and for the expansion of the system to meet future needs.

The manner in which smallholder irrigators farm is to reduce risk (Perret, 2003), which results in the lower cost and input method of farming. The impact is that the crop water requirements and the system can be reduced to suit. This will have an impact on the initial costs and the ongoing operational costs.

The development of limited irrigation systems has been evaluated experimentally. This is further documented in:

- Limited irrigation, (Van Averbeke and Marais, 1991). This method of irrigation is highly dependent on knowing how much water is available to the plant.
- The University of Fort Hare developed the concept of the Profile Available Water Capacity (PAWC) (Hensley and de Jager, 1982).
- Further models of PAWC were developed and these combined with the 'deficit irrigation' concept (Boedt and Laker, 1985, Vanassche and Laker, 1989).
- The University of the Orange Free State utilised the PAWC and deficit irrigation to develop BEWAB (*Besproeiingswater Bestuursprogram)* (Bennie *et al*., 1988). BEWAB (Bennie, 1993) is a computer-based irrigation scheduling programme. The aim is to fill the soil profile to field capacity, under the specified irrigation system, before the crop water demand peaks.

Crosby (2000) indicates that the concept of deficit irrigation was developed to improve water use and resultant yield. Once the soil is at field capacity, deficit irrigation can be employed and the PAWC of the soil used. This type of irrigation can be easily employed and is most suitable for smallholder irrigators. The approach has two primary benefits. These are that the available water is optimised, and that the irrigation system does not need to be sized to cater specifically for peak usage. This in turn, reduces its size and cost.

Two conditions influence the required crop water requirements. These conditions are:

- When employing limited irrigation and low planting densities, Crosby *et al*. (2000) show that the crop water requirements will not be the same as intensive irrigation. If the system is designed on intensive irrigation, then the water supply will be oversized and lead to waterlogging. The system will not be efficient and will result in a more expensive system.

- In very hot and dry areas with high evaporation, plants tend to react differently (Vanassche and Laker, 1989). The Food and Agriculture Organization's (FAO) CROPWAT publication (Smith, 1992) identifies how citrus reacts under these conditions. It was found that the crop coefficient for citrus reduces under these conditions when compared to normal.

3.2.5 Sharing of infrastructure and the need for organisation

In South Africa, there is often a need to share the available water. The sharing of water involves the combined use of infrastructure such as dams, weirs, canals, pumps and pipelines. The water source may not be specific to a farm and the combined use of the source makes the supply more feasible. The farmers using the infrastructure will have to co-operate to manage and to maintain the supply. In South Africa, legislation requires that a Water Users Association (WUA) be formed to oversee this function. The WUA usually comprises the farmers themselves, but may include a Water Service Provider (WSP).

The sharing of infrastructure is not always easy to manage to the satisfaction of all the farmers. Each farmer may have a different system and requirements from the supply. Disputes can occur over who has access to the supply during certain times. The greatest success and flexibility for a farmer is when each has their own independent system that is not affected by the activities of another farmer. Van den Dries (2002) highlights that where there is no harmony in a scheme, it can result in failure of the scheme, or for individuals lower down in the system.

For the farmers there is also the need for organisation and to form a common voice. Aryee (2003) illustrates by work in Ghana where the design and use of technology on a scheme needs to be a combined effort where all the farmers are involved and all have an active voice. Having a common voice is also emphasised by Perrot (2003) as imperative in the selection of the appropriate technology to implement.

3.2.6 Management of irrigation schemes

The management of a system is very important, and externally managed systems have been shown to be dysfunctional over an extended period (Crosby *et al*., 2000). Farmers do not like this method of management and it does not stimulate the sector. These externally managed systems also tend to have high political involvement or meddling. The involvement tends to result in inappropriate finances being spent on schemes that are not functional. There are also on-going social issues that tend to be experienced on these schemes. The farmers involved in such schemes have not being empowered to farm on their own and so become either unable or unwilling to farm on their own. An unsuitable reliance on the state for on-going support has resulted.

There has been very little consideration of farmers in the design of schemes and this in evident in the actions of development agencies, institutions, consultants, managers and, particularly, politicians. Crosby *et al*. (2000) show that this often results in a system imposed on to a scheme with the farmer left to deal with the results in the future.

Where farmers are actively involved and have the freedom to manage their land, Crosby *et al*. (2000) have found that there is greater satisfaction amongst the farmers and ownership of the scheme is evident. It is interesting to note that on such schemes there are greater numbers of male farmers compared to the typical food plot schemes where women tend to be the primary workers. These schemes have a higher social impact than externally managed schemes. They, however, tend to be in a poorer state technically, but this is due to limited or no support advisory services.

The questionnaire of Denison (2004a) illustrates that in a number of provinces, the scheme members identified farm management as a major limiting factor.

3.2.7 Training

In South Africa there is a paucity of advisors with sufficient knowledge of irrigation. The smallholder irrigator who needs to draw from the advisory services is directly impacted. Crosby *et al.* (2000) found that there is no training programme for extension services in South Africa, and hence a lack of advisory knowledge. Those in the extension services need training on both irrigation theory and the actual practice.

The training of smallholder irrigators firstly needs to meet their daily requirements and then extend further to marketing and financial aspects. The training should be practical and hands-on, as this is the best manner to transfer skills.

3.2.8 Market access

Smallholder irrigators experience poor market access in many cases. Denison reports (2004a) that this is a major problem, and yet this did not come out strongly in the questionnaires. A perception of market access as a problem was mainly identified by those consultants working in the area.

3.2.9 Plot size

One of the problems to a smallholder is the size of his land. Traditionally plot sizes have been small and the average size is 2 ha (Denison, 2004a). This has been shown not to be economically viable as the sole income for a farmer. It can further been noted that on schemes in Malawi, Ferguson (2004) found farmers have added to their original plots and may have as many as five plots. This illustrates that schemes, in their general (initial) form, do not provide sufficient area for farmers.

3.3 Feasibility studies

3.3.1 Introduction

Pre-feasibility and feasibility studies are used to motivate for capital investment into projects. This is required to identify whether there is benefit in the use of funds for that particular project. Studies have previously been undertaken, focussing on the following items:

- Large projects with external management;
- Where there is emphasis on socio-economic issues and to promote development; and
- The project's economic viability and cost/benefit ratio.

The study method needs to be continuously updated to incorporate the changing circumstances of irrigation development (Crosby *et al.*, 2000). For existing schemes, there is the added complexity of the existing infrastructure. This needs to be assessed during the study to identify the adaptations required. It must now be ensured that the farmer is able to operate and maintain it over successive years.

The main aim of a feasibility study is to identify developments that could take place. There may be a number of competing options all of which will be evaluated on technical, economic and sustainability issues.

3.3.2 Pre-feasibility studies

(a) Characteristics of pre-feasibility studies

The role of the pre-feasibility is to get the first snapshot of the possibilities of the project. Crosby *et al* (2000) show that since this is the first stage, there is a low level of detail and the objective is primarily to determine whether the project is 'go/no-go'. The study will usually be presented to the relevant decision makers who will decide on proceeding with the project to the next stage of evaluation. Even though there is a relatively low level of detail, there must be sufficient detail to give a true representation of the project with sufficient information given to make an informed decision.

The primary items that the pre-feasibility study must address are:

- The background of the project;
- Identification of the relevant stakeholders, their role with respect to possible conflicts and their strengths;
- Assessment of the irrigation potential;
- Identification of the farmers' objectives, requirements and capabilities; and
- Using the existing information and findings to indicate the project viability.

(b) The impact of the scheme

The pre-feasibility studies should take into account the challenges to smallholder schemes and how these schemes should be developed to provide for greater chance of success (Crosby *et al*. 2000). With the incorporation of the National Water Act (No. 36 of 1998) there needs to be a shift in the planning of irrigation schemes. There needs to be greater focus on the impact of the scheme on the socio-economic hinterland as part of the study. Part of the evaluation has to be the long-term sustainability of the water source. This needs to encompass the quantity, quality and reliability of the source. This then needs to provide the optimum use of the source over the long term in an environmentally responsible manner, providing social and economic benefits to the community.

(c) Study procedures

Participatory irrigation planning is a relatively new concept in irrigation. There has been documentation of various procedures and these are available to planners. These procedures need to be utilised in developing a suitable set of guidelines for South Africa (Crosby *et al*, 2000). Chancellor and Hide (1997) have presented the ongoing revisions for studies in Kenya that are the most documented.There have been research projects in South Africa where prototype methods have been tested. The following methods were tested:

- The 'National Geographic' method is primarily for management to identify priorities and action items on schemes.

- The SAPFACT method is used for quick evaluations with one or two people. It is wider then the National Geographic method and mainly from existing schemes where the farmers are evaluated.

- The Bussing method can be used on an existing or new scheme, but it is important to get the input of all the relevant stakeholders. It is mostly applicable for large schemes or a group of schemes where sustainability of the scheme is the primary item under consideration.

- The Adendorff method is primarily for schemes that will be rehabilitated. Here the communities will have an important role, and an understanding of their needs and skills is of primary concern.

In addition to the above methods, the Sondeo and Participatory Rural Appraisal methods have been recommended for use in pre-feasibility studies.

The overall procedure that is employed is important, not necessarily the specific method. The primary objective is that the best output needs to be achieved, as opposed to the best methodology of planning the output.

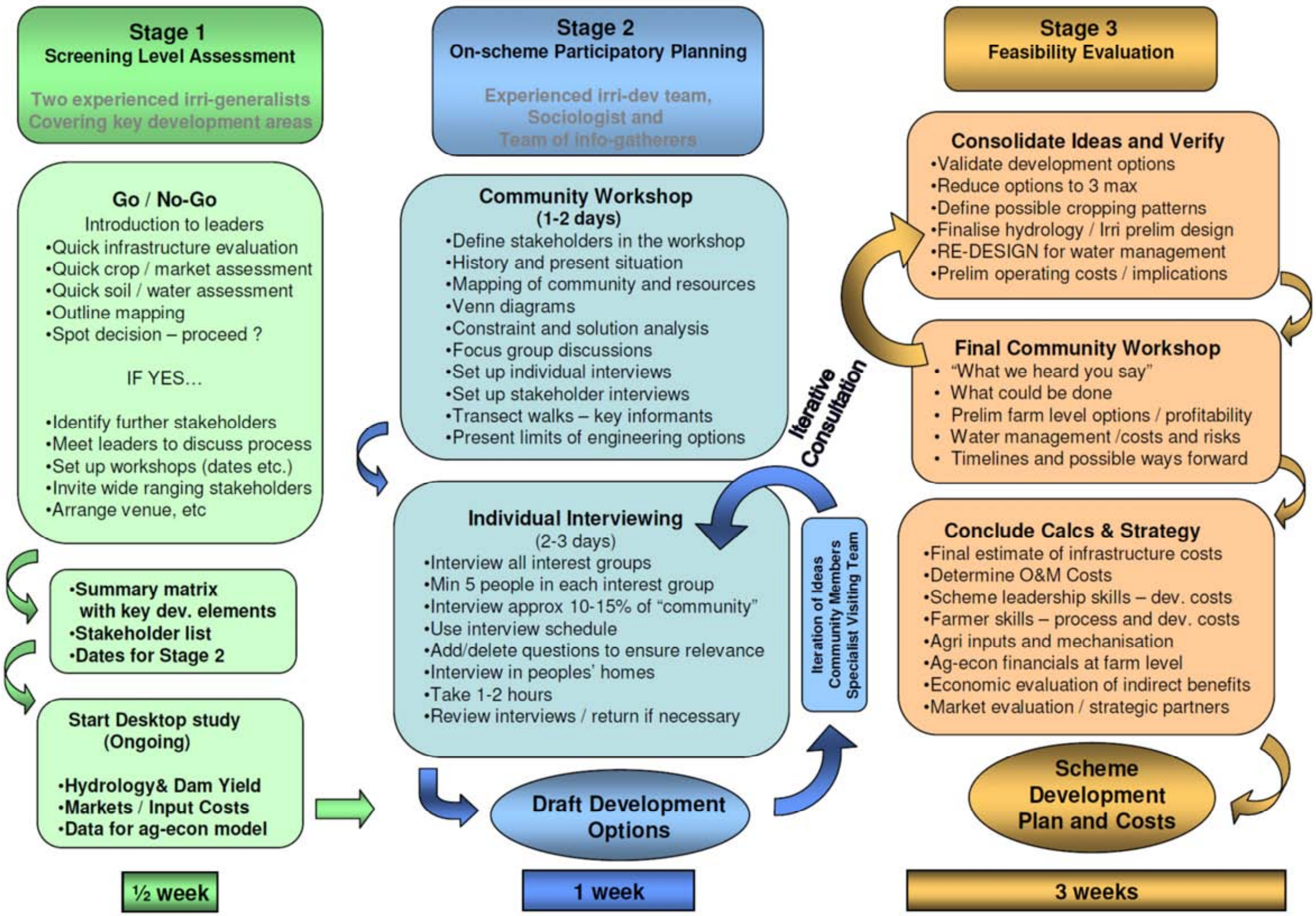
When choosing a method for the study, Crosby *et al.* (2000) highlighted that the context of its use must be understood. The method will then be selected according to the nature of the scheme and skill of those performing the study. The method or combination of methods that are applicable should then be selected and incorporated into the overall procedure of the study.

3.3.3 The ICON irrigation feasibility planning approach

The Iterative-Consultative Approach (ICON) formulated by Denison and Kruger (2004b) combines various methodologies including Participatory Rural Appraisal (PRA), Sustainable Livelihoods, Rapid Appraisal of Agricultural Knowledge Systems (RAAKS) and Farmer Typologies. The ICON approach is intended for Feasibility Studies. An outline of the process is given in Figure 3-2.

The approach is based on a multi-consultative interaction with the beneficiaries, and feedback on social, institutional, technical and financial aspects. The team should consist of sociologists, engineers, agronomists and economists to cover all the necessary aspects of the investigation.

Figure 3-2: Staged process of ICON approach (Denison and Kruger, 2004b)



The approach aims to maximise a two-way information transfer between the beneficiaries and the study team. During the process, the beneficiaries are made fully aware of the implications of different project options and that the best solution will be identified with their involvement. Some of the key aspects of the approach include (Denison and Kruger, 2004b):

- Project boundaries are not delineated by the irrigation scheme;
- There are likely to be conflicting goals and aspirations among the communities;
- Multi-disciplinary approach to the design. This includes detailed plans and budget allocations for infrastructure investment, crop production training, institutional development, land-consolidation and land-market interventions, development of market outlets, and homestead food production in villages; and
- Maximum involvement of all stakeholders.

3.4 Investment costs in revitalisation

The factors influencing costs for the revitalisation of smallholder irrigation projects have been investigated on 314 projects in 50 countries as reported in the Inocencio Report (Inocencio, 2007) and are listed below:

- Project size

  This is the most important factor influencing the costs of the project and the larger the project size, the lower the unit cost. This is primarily due to the engineering economies of scale that result from larger projects. This may further have the impact that larger projects should attract better managers and the agency being most cost-efficient. It was further found that the larger the project, the higher the probability of success or expected rate of return.

- Average size of system

  As with the project size, larger system sizes within the project will have lower unit costs than smaller systems. It was, however, shown that the larger the system, the lower the performance of the project. This implies that the smaller the system in a project, the better the expected project performance. This could be a direct result of the management advantage to be gained from a smaller system. The system then needs to be carefully designed to maximise effectiveness. Management factors therefore seem to have a greater impact on success than the scale of the system.

- Degree of complexity

  The degree of complexity does not affect the development costs of a project. Increased complexity does, however, have a negative effect on the rate of return for the project. This can perhaps be explained by noting that the effectiveness of management resources is dissipated by too great a complexity.

- Government funding

  It was found that the greater the portion of government funding, the lower the unit cost was for the project. The hypothesis of this was that in developing countries, the use of government funding for irrigation projects was more circumspect than that of donor agencies. This resulted in funds being allocated to projects with a greater chance of success. These, in turn, would be those with lower unit costs and thus high rates of return.

- 'Soft costs'

  These costs include components such as engineering management, technical assistance, agricultural support, institution building, training of staff and beneficiary farmers. The higher 'soft costs' on a project resulted in lower unit costs. This counters the thought that the engineering infrastructure and 'soft costs' should result in higher unit costs. This could well be because with higher 'soft costs' there is improved project management and implementation, and the better management of irrigation systems either constructed or rehabilitated in post-project phases. This is achieved though the improved skills and capacities of implementing agent and farmers.

- Rainfall

  The amount of annual rainfall was found not to have a significant impact on the costs of projects. The amount of rainfall did however have an impact on the availability of water. Projects in higher rainfall areas had higher project performance. Therefore, the higher water availability resulted in improved performance.

- Macro economic factors

  The Gross Domestic Product (GDP) of a country has a real effect on the unit cost of irrigation projects. The greater the GDP *per capita*, the higher the unit cost. This indicates that wealthier countries have more expensive projects and lower project performance. One of the factors is that as economies develop, wages increase. As wages increase, more labour saving construction methods are required. This, however, is not sufficient to counter the increased wage rate.

- Farmer contribution to initial costs

  There is no impact on the unit cost where farmers contribute to a project. Where farmers contribute to the initial costs, the project performance increases. This is generally due to greater sense of ownership by the farmers and more sustainable projects.

- Conjunctive water use

  Conjunctive water use is the use of both surface and ground water. This provides for better water availability. It was found that this did not influence the unit cost, but did have a significant improvement on overall project performance.

- Mode of O&M and farmers' participation

  The O&M for a project can be managed in three primary methods. These are by a government agency alone, by government and farmers as a partnership, and farmer-managed. Farmer-managed systems result in lower unit cost projects than with government agency managed systems. The deeper involvement of farmers in the projects allows for tailor-made, appropriate technology that matches the farmers' real needs. This appropriate design has an impact on reducing the project costs.

- Type of crop irrigated

  The capital costs for the irrigation systems for irrigating rice are significantly higher than the costs for the systems to irrigate any other crop type. The more valuable the crop irrigated, the higher the project performance and profitability. Fruits, vegetables and livestock products generally provide for better performance in a project.

3.5 Smallholder production and reduced crop water requirement

3.5.1 Introduction

Irrigated crops are expected to utilise far more water than rain-fed crops, but have greater yields. An estimate of the crop water requirements must be made when considering an irrigation project. Crosby *et al.* (2000) show that the estimation needs to be as realistic as possible. If the estimate is high, it could have a detrimental impact on the decision to proceed further. A system that is designed on crop water requirements that are too high faces the danger of not being economically viable and this affects the sustainability of the project.

There is an understanding that any crop will be stressed should it suffer a water deficit, and this will result in a reduced yield. The present norm in design procedures is to ensure that irrigated crops will not experience a water shortage (Doorenbos and Pruitt, 1977). The aim is to produce crops at an optimum yield considering the soil, water and fertility.

When planning schemes, the general procedure of calculating crop water requirements is to calculate them according to the design norms. This results in crop water requirements that are applicable to intensive farming practices. The infrastructure is then designed to the peak water requirement and to the cost of the infrastructure estimated. When a smallholder irrigator scheme is considered, the yields of the farmers are generally reduced, as has been observed in practice (Crosby *et al.*, 2000). The other aspects which result in the reduced yield are, however, often ignored and the same system is generally proposed that would have been proposed for an intensive farmer. This has a negative impact of the financial evaluation of the project and may result in the project being rejected on sustainability grounds. If a realistic approach was adopted to calculate crop water requirements, the proposed infrastructure is likely to be lower both in capacity and cost. This would have a positive effect on the financial viability, and a project may then be approved rather than rejected.

3.5.2 Crop production and irrigation requirements

When the crop water requirement is estimated, the calculations are for a crop that is producing its full yield. Smallholder irrigators, however, normally do not produce this theoretical yield. Due to the farmers being far more risk averse than intensive farmers, they are unlikely to spend as much on inputs as the intensive farmers. They do this to prevent complete loss should there be a catastrophic failure of the crop. Smallholder irrigators are more conservative and aim for a lower yield (Crosby *et al*., 2000). They further reduce costs by having a lower planting density and lower applications of fertiliser. The canopy of the crop is unlikely to be 100 % as it may be with an intensive farmer, and actually may equate to that of a rain-fed crop. The yield is therefore lower than the maximum achievable, but still good when considering the plant density. The water requirements may also be much lower than those estimated in the planning stage.

An important aspect of an irrigation project is the yield of the crops. Even though a smallholder irrigator may have a reduced yield, it must still be sufficiently high for sustainability. A common problem with smallholder schemes is that they do not achieve suitable yields and have varying crop yields. Crosby *et al.* (2000) identify the need for farmers to have a better knowledge of how to manage their water and irrigate their crops under conditions where they have water deficits.

An interesting perspective is that found by Fonteh (2006) in Cameroon where smallholder irrigation is actually the preferred methodology, as it is understood to be more effective. This occurs as the primary rainfall is during two months of the year. This illustrates that effective water conservation can also take place using reduced water demands.

3.6 Estimating crop evapo-transpiration

The first step in planning water use is the calculation of how much water is needed by the plant, that is, by estimating crop evapo-transpiration. The accepted procedure internationally for this estimation is CROPWAT (Smith, 1992). CROPWAT is a computer program that calculates the crop water requirements for planning and design. It is an improvement over A-pan methods but does not allow for cycle lengths or the partial wetting of the soil (Crosby *et al*., 2000).

The estimation of crop water requirements is not a simple procedure (Crosby *et al*., 2000). It has been observed that smallholder irrigators utilised less water than estimated. This is likely due to non-standard conditions and production methods. Modern systems such as centre pivots and micro systems are being operated using less water than calculated at planning. To calculate the necessary water, a more sophisticated model is required. The solution is to allow for separate calculation of the evaporation from the soil and the transpiration of the plant. The program SAPWAT (Crosby, 1999) allows for these separate calculations, and further allows for the modification of the crop factors of selected crops. This can then be used to account for situations that do not fall into the standard irrigation practice and are suitable for smallholder irrigation design.

3.6.1 Using SAPWAT

SAPWAT can be used for the calculation of crop water requirements. The use of SAPWAT and its application discussed in brief below. This discussion has been summarised from the sections of the Crosby et al. (2000) report.

(a) Climatic data

There are 350 weather stations in South Africa. The appropriate station for the project can be selected from an on-screen map. The nearest weather station which best represents the project site must be accurately determined.

(b) Reference evapo-transpiration (ETo)

A reference evapo-transpiration can be derived and this is presented on a monthly basis. This has been determined from long-term, mean daily values. The values are calculated using the Penman-Monteith method.

(c) Default crop factors

The program allows for the selection of a specific crop under consideration. The geographical region and planting date both have an impact on the calculated crop factors. This is due to variations in conditions that are experienced in different regions.

(d) Modifying crop factors

It is possible to modify the default crop factor shown by the program. This is achieved by the following:

- The effective leaf area can be reduced to less than 100 %
- The time between irrigation events is increased. Under this option, the crops reduce the water in the soil and irrigation does not fill to field capacity. With the soil being dry, the soil evaporation will reduce, resulting in a lower crop factor.
- Reducing the wetted area to less than 100%. If the full area is not irrigated, then the full area is not subject to the same evaporation and consequently the crop factor decreases. This is of greatest significance during the initial stages of growth when the maximum soil area is exposed.

(e) Water requirement

The Water Requirement section shows crop evapo-transpiration by month, rainfall, effective rainfall and the monthly irrigation requirement. In the calculation of the irrigation requirement the effect of rain has been considered and the implications of the efficiency of the system.

The program allows for three season conditions: favourable, normal and severe. These are calculated on a one in five-year basis. The efficiency of the system is selected by entering the spray losses including run off and the distribution losses. The distribution losses incorporate both deep percolation and the uniformity coefficient of the system.

3.6.2 Crop factors applicable to smallholder irrigation

Smallholder irrigators are more conservative in the management of their farms. Since they have smaller budgets, they spend less on input items. This is a safety mechanism to allow for funds in the following year should the current year be catastrophic. This often results in a reduced planting density and limited fertilisation when compared to an intensive farmer. With the reduced planting density, Crosby *et* *al.* (2000) indicate that the resultant crop canopy is less than 100 %. This is particularly evident with vegetables grown on wide beds. This results in the water requirements per hectare being less than for intensive farms. A further result of the reduced plant density is the wetted area. With the reduced plant area the soil area, where no irrigation takes place, actually increases and the wetted area decreases. This is only applicable to systems such as furrow irrigation where the full area is not irrigated. The wetted area could reduce to only 60 % of the full area. It is possible to develop a crop factor specific to a project by incorporating the canopy cover, wetted area, irrigation cycle, climate, growing season and location.

When developing a project, a choice between designing for the reduced water demand and the full irrigation requirement for intensive irrigation must be made. There are those who call for the design to cater for the full requirement even if smaller volumes are required (Crosby *et al.*, 2000). The intention is that, over the longer term, the farmer is to develop and achieve full production levels requiring the full water requirements. The answer to this dilemma can only be solved on a case-by-case evaluation. If the farmer is expected to improve and achieve the full levels of production, then it will be of benefit to design the scheme in that manner. However if the farmer does not desire or is unlikely to ever achieve these production levels, the additional capacity will be underutilised and capital wasted.

3.6.3 Designing for irrigation management

To manage the irrigation application, scheduling is used (Crosby *et al.*, 2000). This involves the varying of the quantity and frequency of irrigation to suit the crop requirements during the season. It is not an easy process to apply in practice, but the systems are designed to cope with the demands and the farmers are expected to implement scheduling. The irrigation system is usually designed to supply the peak water requirement of the season. This will require that early, and again later, in the season, the farmer will need to alter the amount of water applied. This can be achieved by either increasing the time between irrigation events or reducing the application time to apply less water. This should be done to prevent over-irrigation.

To perform scheduling the farmer needs to calculate the water requirements (Crosby *et al.*, 2000). This can be done by either measuring the water in the soil profile or by profit-loss calculations by measuring the atmospheric demand. From the measurements, the irrigation requirement can be calculated and the amount of water to be applied can be adjusted. This is not an easy process and is even more difficult for the smallholder irrigator to achieve.

The design of the system can vary depending on the circumstances of each project. There may still be the need to design the system to supply the peak water requirement when the soil reservoir is a limiting factor. When it is possible to utilise the soil profile, Crosby *et al.* (2000) show the frequency of irrigation can be extended and this can result in simplified management strategies. A shallow-rooted crop requires frequent irrigation as it draws water from a reduced profile. A deeper-rooted crop allows for varied management options and use of the soil profile. Scheduling can, under the right circumstances, be abandoned making irrigation management far simpler. The system of irrigating the same amount of water throughout the season can be used on suitable and deep-rooted crops. By following this procedure, there can be over-irrigation at first until the soil profile it filled to field capacity. Over the peak period, the water profile is depleted and then fills again towards the harvest.

When using this method, the size of pump and pipe work can be reduced, as the peak requirement is not considered, but rather the average application rate. This will also have an impact on the operational costs and possibly have a positive effect on nutrient loss and salination. There is a further benefit in that, with the reduced capacity of the system, there is a built-in safety factor to prevent over-irrigation (Crosby *et al.*, 2000). With this system, the greatest benefit is the management of the irrigation system and applications. Scheduling is not required and the irrigation application does not need to be varied. The system must, however, be designed, *ab initio,* to operate in this manner and planned by the designer and applied as such by the farmer.

This strategy is not usually applied in South Africa. Only when BEWAB (Bennie, 1993) is utilised is this system generally applied. The system is perceived to be difficult to operate and design (Crosby *et al*., 2000). With this fear of the system, farmers and designers are reluctant to implement the strategy. The effectiveness of the strategy is still to be determined in South Africa.

Another approach is that highlighted by Martin et al. (1990). They propose a high-frequency irrigation approach. The approach consists of three to seven days between irrigation. The approach aims to maintain a high water content in the upper root zone and, in doing so, attempt to remove plant stressing.

3.6.4 Impact of water shortages

A general concept of those who design irrigation schemes is that, should the crop not have sufficient water, it will become stressed and that there may be a total crop failure. Crosby *et al.* (2000) consider this to be a misapprehension. Crops such as maize can have critical reductions in yield. If the water to the crop is reduced and the crop becomes stressed, the crop will not be devastated. A reduction in the yield will occur. As an example of the extremes, a comparison of the yield from irrigated crops and rain-fed crops may be cited. The reduced water will affect the yield, but this may still be satisfactory and, because the crop has been stressed, this does not mean that it will be a complete loss.

A number of factors all affect the yield of a crop and it is not simply a measure of the amount of water applied. The factors, conclude Crosby *et al.* (2000), include the crop variety, fertiliser, spraying and crop density. The yield of the crop will be determined by the most limiting factor and if water is not the limiting factor, then no matter how much more water is applied it will not be of benefit to the production. This is best seen with deficit irrigation.

3.6.5 Status of conventional deficit irrigation

The method of deficit irrigation is used throughout the world, particularly where water availability is an issue. One interesting example in India is highlighted by Crosby *et al.* (2000). There are schemes there that use the water to supply the basic needs of the crops. The water application is to prevent failure of the crop rather than supply the peak requirements. A term that could best be applied to the method is ‘partial irrigation’. Even though there is irrigation, it is not at the calculated peak amounts required, and so may well be the limiting factor. It would then be expected that reduced yields would be achieved.

Another interesting example shown by Crosby *et al*., (2000) is found in the Great Plains area of the USA. This is a semi-arid part of the country. Farmers have irrigated double the area with the same amount of water expected under normal conditions. There are even those who have extended this to three times the area.

In order to effectively use this method, farmers must balance water requirements and the other inputs required. Smallholder irrigators in South Africa have applied this to their benefit especially where there is limited water available (Crosby *et al*., 2000). Even under these circumstances, with the correct application of the method, high efficiencies can be delivered.

SAPWAT can be an important tool when using the method. It can be incorporated into the planning process by designers and facilitators. This will allow for an estimate of the water needs of the farmers for their specific condition.

3.7 Farmer typologies

Both Denison and Manona (2006) and Van Averbeke and Mohamed (2005) worked on typical farmer typologies that exist on irrigation schemes. It is useful to have these typologies so that the farm use can be understood and the correct application applied and designed.

The farmer types primarily hinge on the risk they are willing to take or rather the minimization of risk and loss of money. This then determines how they operate and the category in which they can be classified. Each farmer type also measures success according to its own criteria, which may not be financial. From these, the following farmer types can be utilised:

(a) Business farmer.

This type of farmer is primarily a commercially-oriented producer looking to produce an income from their farming activities. They, in general, have higher skill levels, understanding of markets and greater financial resources. These farmers are likely to accept higher risks and aim for higher yields from their crops.

(b) Smallholder farmer.

These farmers are traditionally plot holders. They do not generally rely only on farming, and generate income from a variety of livelihoods. They are more risk averse than the business farmer and use lower-risk farming styles. They may struggle to be financially sustainable on larger schemes and on pumped systems with high O&M costs. They are more suited to gravity schemes with lower annual costs. They will generally reduce their inputs to reduce risk and will accept the lower yields achieved. They will also rely less on outside markets for their cash income.

(c) Equity labourer

Increasingly, there are greater numbers of large expensive irrigation schemes that are open to partnerships. On such schemes, there are a number of smallholders who would not be able to farm in a business farmer model. There is scope for an outside commercial partner to operate the scheme and farming enterprise. In such a scenario, the plot holders will make their resources available, being soils, water and infrastructure. The smallholders will further enjoy the opportunity of employment as labour and receive dividends from the profit of the enterprise.

(d) Food producer

The food producer may be a smallholder on a scheme. They have limited access to resources such as labour and finance. Generally, food producers are on the poverty line, and their objective is to supply the household with food. They want to avoid risk completely and may not use irrigation due to initial costs, risks, or their own skill level.

It is perhaps prudent further to define commercialisation in the context of smallholder irrigation. In its simplest form, commercialisation in the context of smallholder irrigation is the monetisation of the rural economy and how the smallholder irrigator is incorporated into the wider market (Sakoni, 2007).

4 METHODOLOGY

4.1 Background

This research is based on the input data from a project undertaken by Arcus Gibb for the Department of Water Affairs, being the Eastern Cape Resource Poor Farmers Irrigation Pre-Feasibility Study: 10 Scheme Reports (Arcus Gibb, 2004a-f).

Figure 3-2 shows that the approach follows the process of consultation, analysis and return of information to the communities and farmers. The process is carried through a number of cycles that inform both the community and consultants working on the project. The process moves from a 'high level' conceptual solution at Phase 1, becoming more defined and moving to a sufficiently detailed solution.

4.2 Use of information from Arcus Gibb assignment

The Arcus Gibb assignment provides the base data for this research. The pre-feasibility study involved a number of aspects, all of which influenced the design. These are summarised in the following items:

- The field investigations of the water source for each scheme;
- The consultation with the scheme members directed the system design to the most appropriate irrigation system to match the skill levels;
- Identification of existing infrastructure, suitability and rehabilitation options;
- Soil potential mapping to determine soil suitability, irrigation system suitability, scheme demarcation and crop suitability;
- The detailed evaluation identified the most suitable and financially viable options for each of the schemes. Only those selected options have been utilised and the others removed from the research; and
- The inputs and calculations of the financial evaluation including yields, gross margin, net present values (NPV), rate of return and annual cash surplus.

4.3 Work Performed

The tasks performed by the researcher during the Arcus Gibb project assignment include:

- Identification of existing infrastructure, suitability and rehabilitation options;
- Calculation of crop water requirements;
- Sizing of proposed infrastructure; and
- Costing of capital and O&M costs.

4.4 Schemes investigated in pre-feasibility study

The 10 schemes that were investigated under the pre-feasibility project are listed below and are shown on drawing A1 in Appendix A:

Table 4-1: Pre-feasibility scheme identification

Scheme name	Location	Size (ha)	Water source	Existing or proposed
Qumanco	Ncora	2,000	Ncora Dam	Existing bulk
Ncora Extension	Ncora	1,000	Ncora Dam	Proposed
Kruisfontein	Humansdorp	20	Seekoei River	Existing
Tamboekiesvlei	Kat River	45	Kat River Dam	Proposed
Philane/ Ncambedlana	Mthatha	110	Mthatha Dam	Existing
Wolf River	Keiskammahoek	15	Sandile Dam	Proposed
Port St Johns (Umzimvubu & Mantusini)	Port St Johns	120	Mzimvubu & Mngazi Rivers	Proposed
Coega Valley	Coega	250	Boreholes	Existing
Kama Furrow	Zanyokwe	60	Keiskamma River	Existing bulk
Qamata Section 6	Qamata	642	Lubisi Dam	Existing bulk

From the above list of schemes, Qumanco, Ncora Extension, Qamata Section 6 and Coega Valley did not proceed to detailed implementation planning. This was due to fatal flaws being identified which prevented interventions in these projects from proceeding further.

4.5 Selection of schemes for research

The full list of schemes for the pre-feasibility study is shown in Table 4-1. From these a number of schemes have been selected to form the basis of this study. These are shown in Table 4-2. Schemes that were eliminated during the Arcus Gibb study and the Port St Johns scheme were not considered for this research. The Port St Johns scheme consisted of a number of individual farms where river water was pumped to the lands. The Port St Johns farms are the same type and size as the Mantusini scheme and therefore will not provide any further information that could not be determined using information from the Mantusini scheme.

Table 4-2: Study scheme selection

Scheme Name	Location	Size (ha)	Water Source	Existing or proposed
Kruisfontein	Humansdorp	20	Seekoei River	Existing
Tamboekiesvlei	Kat River	45	Kat River Dam	Proposed
Philane/ Ncambedlana	Mthatha	110	Mthatha Dam	Existing
Wolf River	Keiskammahoek	15	Sandile Dam	Proposed
Mantusini	Port St Johns	120	Mngazi Rivers	Proposed
Kama Furrow	Zanyokwe	60	Keiskamma River	Existing bulk

The scheme size identified in Table 4-2 is the initial anticipated scheme development. During the investigation, the area recommended for implementation would then be revised on items such as water availability, soil suitability and skill levels of scheme members.

The details of the evaluation performed in this research are given in Chapter 6 and the underlying data from which the recommendations could be made in Chapter 5.

4.6 Preferred implementation option

The proposed system for each scheme was developed in consultation with the beneficiaries and was subject to the characteristics of each scheme. During the study, multiple options were developed for most of the schemes. These options were evaluated economically. Only the economically most favourable option for each scheme was used in the analysis presented in this research.

The most favourable economic options were developed for the two primary farmer types that are considered, namely, the commercial farmer and smallholder irrigators. For each farmer type, the water demands were calculated and the favourable option designed to cater for the required flow capacity.

4.7 Scenario terminology

The research investigates three scenarios of scheme development with two farmer types. For the purpose of the research, the amount of water and how it is used will be referred to as the Level of Supply (LOS)

The first scenario considers normal design guidelines with a commercial level of water supply and use. For the purpose of the research, the scenario will be called the commercial LOS.

The second scenario is a smallholder irrigator level of water use and supply and the appropriate reduced design to complement the water use. The scenario will be called the smallholder LOS.

The third scenario combines aspects of the previous two scenarios. The scenario makes use of the commercial LOS scheme design, but the water use of the smallholder LOS. This scenario is to identify the impact of the over-design of a scheme, or the design of scheme for a commercial water use but with the farmers operating it at the demand level of a smallholder. This scenario will be called the Commercial Underutilised LOS.

The Commercial Underutilised LOS makes use of the data of both the commercial and smallholder LOS. The capital costs will be taken from the commercial LOS and the water use from the smallholder LOS.

The purpose of the Commercial Underutilised LOS is to address the scenario where the designer is expecting the smallholder to eventually graduate to a commercial operation. The evaluation will investigate what the initial differences between the three options are, and which are the most efficient.

4.8 Process of design

The proposed infrastructure for the schemes in the study was determined on a scheme-by-scheme basis depending on the requirements. There were, however, some preferences in the design of the schemes. These are explored in further detail in section 4.8.2 to 4.8.5. The design has been done following the guidelines of the Irrigation Design Manual (ARC, 2003).

4.8.1 Crop mix

The Arcus Gibb (2004 a-f) study did not recommend a specific fixed crop mix as there are a number of local as well as personal issues that affect these decisions. The crop mix is possibly the most important management decision a farmer makes and farmers should be accountable for their own decisions in this regard. It is how a farmer makes these decisions that determine the overall success of the enterprise. The proposed crop mix is done in order to produce an average economic model for a hectare of mixed crops. This economic model is in turn used to determine the financial and economic feasibility of the irrigation scheme.

The crop mix proposed by the agricultural economist of the Arcus Gibb (2004 a-f) study approximates the average returns on a hectare of mixed crops and vegetables by an emerging farmer. The proposed mix was based on the agricultural economist's observations from participative reviews of farmer groups. The mix was compiled to represent a realistic return from a hectare of crops under normal farming conditions, in the context of the schemes. The proposed mix is not a recommendation to farmers as the ideal mix for maximum agricultural and financial return, which will vary seasonally and annually on a wide range of factors.

The representative crop mix on which the financial evaluation is based consists of six summer crops and one winter crop with a total utilisation of 130%. The full area will be planted to summer crops, but only 30 % of the total available area will be planted to winter crops.

The areas for each of the six summer crops are apportioned as follows:

- green mealies - 40 %,
- potatoes - 5 %,
- tomatoes - 5 %,
- carrots - 10 %,
- maize - 20 %,
- dry beans - 20 %.

Costs, yields and prices are based on realistically attainable figures based on 2005 values when the Arcus Gibb (2004 a-f) study was undertaken. The costs, yields and prices selected reflect the level of skill and management that can be anticipated from smallholder farmers. The costs have been escalated at 10 % per annum to a 2007 escalated price for comparison with the 2007 engineering costs.

4.8.2 Crop water requirements

The design makes use of a proposed cropping pattern for each of the schemes. The cropping pattern was developed during the feasibility study. The cropping pattern allows for a conservative 130 % utilisation. The summer crop of vegetables and maize was to cover 100 % of the irrigable area with 30 % utilised for the winter vegetables crop. The vegetables include potatoes, green beans and cabbages. The cropping pattern has not been repeated in detail, but has been incorporated in the calculation of the crop water requirements. The crop water requirements for each crop type were calculated using the SAPWAT software.

The smallholder LOS has a reduced crop water requirement. The BEWAB software has been used to estimate the approximate water use reduction due to the lower yields and crop density.

An important aspect of the crop water calculation was the total water use needed for the developed area. During the investigation, the water available from the resources was compared to the crop water requirements. The irrigation area was then limited, if required, to match the available water.

4.8.3 Component sizing

The sizing of the infrastructure was done according to the peak month of the cropping pattern. This was done to ensure that the farmers could supply the required water at any stage of the crop life cycle. It must be noted that for the smallholder irrigator, the water requirements have already taken into account the reduced water demand. The reduced water demand then translates into the varied design output compared to the commercial LOS.

(a) Dams

A generally accepted level of assurance of the supply of water for irrigation is 80 %. The resources will therefore be required to meet this minimum assurance level. The dams' capacity will need to be sized and modelled to achieve the required level of assurance.

(b) Pipelines

The sizing of the bulk pipelines to storage reservoirs was based on the daily water requirements for the peak month. Bulk lines that supply the infield directly will, however, be sized on the flow requirements of the individual set. The flow rates in pipelines would, however, be limited to a maximum 3m/s.

4.8.4 Natural resources

(a) Water availability

The available water can directly influence the type and size of scheme that is possible. The limitation of dams to provide water at 80 % assurance of supply and available water from a river may result in a scheme size being limited. The limitation of the scheme size is a result of the limitation of water rather than a limitation in suitable soils.

(b) Soil potential

A farmer is at an immediate disadvantage when the soils available are not suitable, or require additional management to irrigate. For a smallholder irrigator, it is generally not suitable to irrigate soils that are medium- to low-potential. The decision to proceed depending on the soils was taken on a case-by-case situation. The more equipped the farmers were to manage the soils, the greater the possibility that a lower class of soils was acceptable.

4.8.5 Engineering preferences

(a) Dams

The type of dam that should be selected for a site is generally dependent on the topography and founding conditions of the site. Bearing in mind that the selected schemes are for smallholders, an earth dam is likely to be the most appropriate embankment type. An earth dam is also likely to fall into the construction cost range that is applicable for a sustainable scheme.

(b) Bulk pipelines

The size and pressure requirements of the bulk mains will determine the material type that is most suitable. Generally pipes 350 mm in diameter and smaller are the most cost effective when using the MPVC pipe material. These pipes are suitable for pressures below 200 metres.

For 400 mm pipe diameters and above, steel is the predominant option. GRP can be selected, but installation requires skilled contractors. They are more susceptible to damage during construction and installation may extend outside the skill range of most farmers. Ductile Iron (DI) has the same benefits as steel and in certain diameters can provide for a more cost effective option. These pipes are, however, all imported and thus the end user is susceptible to price fluctuations and long delivery lead times.

(c) Pump stations

Centrifugal pumps were identified as the preferred pump for these schemes. These pumps allow for the greatest flexibility in operations and provide some of the best efficiency rates. A submersible pump will be required for specific applications. Submersibles, however, are most suitable for low lift applications but run at considerably lower efficiencies than centrifugal pumps. Submersibles will therefore be best for low lifts out of a river to a booster pump station with centrifugal pumps.

(d) Reservoirs

Irrigation water is most efficiently stored in open water dams. Should a reservoir be needed, a concrete or steel tower can be selected. These are, however, considerably more expensive options. A steel tower is approximately 10 times more expensive compared with a concrete reservoir of the same capacity. The combination of a concrete reservoir and pump station is a further option. The preference between this option and the elevated steel tank depends on site-specific conditions and the life cycle cost.

(e) Distribution mains

The distribution mains will be 350 mm in diameter or smaller, with pressures below 90 m. The most suitable pipe material will then be MPVC.

(f) Infield irrigation infrastructure and equipment

The infield system must be done in conjunction with the farmers who use the system. Once the system is selected, the materials can be chosen. Table 4-3 lists the general uses:

Table 4-3: Infield systems and primary material types

System	Particulars	Primary material type
Drip	Above ground	LDPE
Dragline - Sprinklers	Mains below ground	MPVC
Dragline - Sprinklers	Mains above ground	Galvanised quick couple
Centre pivot	Above ground	Galvanised pipe work

4.9 Financial evaluation

4.9.1 Crop budgets

Seven crops have been used from three different crop categories in section 4.8.1. The crops are green mealies, potatoes, tomatoes, carrots, maize, dry beans and cabbage. For each crop a detailed breakdown of costs, yields and income are provided as a value per hectare. This is done in order to calculate gross margin or the return on the investment. These costs exclude management of each of these crops. Selling prices used are indicative market prices. Transport costs to markets have been included as a cost item. The seven crops selected above have been chosen as they provide a fair representation of crops and profitability that can realistically be achieved.

4.9.2 Evaluation details

In terms of efficiency of production the evaluation is based on smallholder irrigators achieving production levels of 60 % mainstream commercial yields. The smallholder “targets” for farmer productivity may be considered to be low, when compared with fully commercial yields as described in Computerised Enterprise Budgets (COMBUD) for example. The agricultural economist’s has selected values that are realistic and present a balanced, if somewhat conservative, picture to inform and guide decision-making on investment in irrigation development.

- The financial analysis includes the DWA Bulk Water subsidy of R 10,000 per hectare with a maximum of R 50,000 per eligible farmer.
- The analysis does not make provision for investment in replacement of infrastructure during the period analysed.
- Project outflows include the cost of the refurbishment with a contingency provision of 5 %, the cost of small tools and manual spray equipment and overheads which include irrigation power costs, water charges and fees and irrigation maintenance costs.
- The tax rate used for the financial evaluation is 15 %. It is suggested that the farmers seek classification as "small companies" in terms of the South African Revenue Services and structure their businesses accordingly. Further attention may be required to this aspect to ensure that the most tax efficient system is used. If a farmer is taxed on an "individual" basis the applicable tax rate will be higher. In the cases of farmers with access to only a few hectars per individual (ie. where the total income per individual is less than the income tax threshold) then the cash surplus shown in the tables will be exceeded by 15 % as no income tax will be due.
- Infrastructure loans will be at an interest rate of 8 %.
- It is assumed that farmers will require loans for 100% of their operational costs during the first 2 years and that thereafter they will reduce their requirements to 50% of the total production expenditure and utilise retained cash resources to meet the non-financed costs

4.9.3 Fixed water charges and irrigation maintenance costs

Water charges and fees (WUA's and CMA's) and irrigation maintenance costs (bulk and infield) of the irrigation systems have been calculated and included in the overall evaluation.

4.10 Basis of evaluation

The calculation of the costs of the schemes and evaluation does not take into account the wide array of aspects that influence irrigators. The initial capital investment of the schemes chosen covers only the construction and related engineering fees. There should be further funds available that cater for crop training, for organisation and for institutional development. The training requirements are not always, however, directly linked to the scheme type and size, but rather to the number of beneficiaries and skill levels.

The scheme types are also limited in the variety of infrastructure. The pump-based schemes are only sprinkler and dragline based. There is slightly more variation with the gravity schemes. The schemes include sprinklers and draglines, drip irrigation, and short furrow flood irrigation. The analysis will, however, be biased toward draglines and sprinklers. The results will therefore be limited to the cost associated with these pre-selected options.

The annual operation and maintenance costs were calculated based on the actual infrastructure. The costs take into account the need to repair and replace equipment and pipe work. A large portion of the O&M costs is attributed to the electrical costs of the pumping equipment. The costs for the smallholder schemes were originally calculated for the Arcus Gibb (2004 a-f) study. These were calculated at 2004 prices. For the research the costs for the commercial scheme were required and calculated in 2007. A new calculation of the smallholder costs could be done at the same time rather than escalating from 2004 to 2007 as it will provide for more accurate results.

The O&M costs account for DWA water charges of 67 cents per m^3 of water. The Kama Furrow, Wolf River and Ncambedlana also have extra management charges of the formalised Water Users Associations on the schemes. These costs are R 250 per hectare.

There is no allocation for labour in the O&M costs. This evaluation will, therefore, give only input on the impact of infrastructure on the annual running costs.

4.11 Appendices

The explanation of each of the items and examples of the calculations in the appendices are given in greater detail in the sections below.

4.11.1 Appendix H and I

Each of the item components in Appendix H and I have been cost on a unit basis. The unit rate for the item includes all aspects of the work to be performed and the additional input of labour, plant, materials and ancillary components to provide a complete item.

- Lump sum items are estimates for all inclusive works for a particular item. Since there are a number of small actions these have been incorporated into a single figure;
- Earthworks allows for all aspects of excavation and placement for the compete task;
- Concrete channels allows for the excavation, shutter works, reinforcement, concrete and floating to construct a linear metre;
- Diversion boxes the excavation, shutter works, reinforcement, concrete and floating to construct a single complete box;
- Pipeline rates allow for the trench excavation, bedding, pipe material, laying of the pipeline, backfilling, pipe fittings and valves;
- Reinforced concrete rates allow for the shutter works, reinforcement, concrete materials and the labour to construct the item;
- Mass concrete rates allow for the shutter works, concrete materials and the labour to construct the item;
- Electrical and mechanical components incorporate all aspects of the pump station. The civil structure, pumps, valves, pipework and electrical equipment;
- The supply of an electrical line is the complete cost to construct a kilometre of the infrastructure. This includes for all materials, labour and plant to construct the electrical supply line to Eskom standards;
- Infield infrastructure has been based on the requirements to cover short sections of the fields based on standard practice for a 1 hectare area. The type of pipework and related costs are specific to the installation type being above or below ground, quick couple pipework, PVC pipes or drip irrigation; and
- Where fencing has been allowed, a Bonax type installation has been included with the costs allowing for the excavation and installation of support poles and the installation of the wire mesh.

The additional allowance for the preliminary and general items has been catered for with an additional 15 % based on the subtotal for construction. A further 10 % was allocated for contingencies. Since the projects are still to be designed, a future 16 % has been catered for to accommodate the design and construction supervision costs.

4.11.2 Appendix J to L

The item costs from Appendix H to I have been incorporated into these calculations to determine the O&M costs for the schemes and LOS. The associated maintenance costs for the civil and mechanical works have been calculated as a percentage of construction value of 0.5 % and 4.0 % per annum respectively. The on-going operational costs have been calculated as follows:

- The cost of water has been based on the DWA charges of the region of 0.67 cents per cubic metre of water. For Kruisfontein 132,239 m^3/annum of water x water tariff of 0.67 cents = R 866.00 in water charges;
- The electrical costs for the operation of the pumps have been based on the appropriate Eskom tariff for based on the electrical demand of the pumps and the average operating hours; and
- No allowance has been made in this section for staff and vehicles as this has been allowed for in the gross margin costs.

4.11.3 Appendix M to O

For each of the crops selected in Section 4.8.1 the expenses and income has been calculated. The underlying philosophy is described in Section 4.8.1. The Kruisfontein commercial LOS calculations shall be used as an example.

The expenses include land preparation, input costs, labour, irrigation power (Eskom power costs), and harvesting and packaging. The cost of each of these items was originally selected by the agricultural economist from the Arcus Gibb projects (Arcus Gibb, 2004a-f). The cost of each item was escalated at 10 % per annum from 2005 to 2007.

The yield for a 1 hectare of produce based on COMBUD rates and the selected average selling price for 1 hectare provide the gross income. For the COMBUD yield of green mielies of 12,500 cobs at sold at an average selling price of R 1.50 per cob provides a gross income of R 18,750. To determine the gross margin the expenses are subtracted from the gross income. The gross income of R 18,750 minus the expense of R 7,987 provides a gross margin of R 10,763.

The gross margin has been calculated on a 1 hectare area. To calculate the gross margin for the range of crops for each crops gross margin has been divided by the proportionate cropping area. This provides a 1 hectare gross margin which can then be applied to the applicable area under irrigation. Green mielies will be cropped over 40 % of the area. The gross margin in then multiplied by 0.4 to provide a gross margin of R 4,305.20 to the average 1 hectare area. The remaining crops then provide the remaining portion to achieve the average 1 hectare gross margin of R 28,659.20 per annum. The net project return is then calculated using the 1 hectare gross margin for all the crops over the total area of 20 hectares. The net return of R 573,184 is calculated by the 1 hectare gross margin of R 28,659.20 multiplied by the total area of 20 hectares.

4.11.4 Appendix P to R

The calculations for the Kruisfontein commercial LOS is used as an example of the calculations for the financial evaluation. For each item and the calculation of year 1 is explained in Table 4-4 below.

Table 4-4: Calculation details for Appendix P to R

Item	**Description**
Area under irrigation	The area under irrigation for the year
Production cost	The expense shown for the crops in Appendix M to O. R 22,392.15 (1 ha average cost) x 20 ha = R 447,843.00
Machines, equipment & tools etc	Other equipment required
O&M of infrastructure	The O&M costs from Appendix J to L = R 4,093.78
Infrastructure loan repayments	The cost of infrastructure from Appendix H of Q 641,555.72 with a 5 % contingency of R 32,077.79 = R 673,633.51 less the subsidy of R 200,000.00 = R 473,666.51 The total is then subject to a standard financial repayment calculation with 8 % interest to get the annual cost.
Working capital repayments	The repayment costs of the working capital loan with 12 % interest per annum. = R 451,936.78 x 12 % = R 506,169.19
Sub-total	The sum of the expenses = R 1,076,730.54
Gross income	The income shown in Appendix M to O = R 51,051.35 (1 ha average income) x 20 ha = R 1,021,027.00
Subsidy	The government subsidy of R10,000.00 per ha = R 10,000.00 x 20 ha = R 200,000.00
Working capital loan	The working capital requirements to cover the operational costs and consists of the production costs of R 447,843.00 and O&M costs of R 4,093.78 = R 447,843.00 + R 4,093.78 = R 451,936.78
Sub-total	The sum of the income = R 1,672,963.78
Net income	The difference between the income and expenses = R 1,672,963.78 – R 1,076,730.54 = R 596,233.24
Tax	A tax rate of 15 % has been applied to positive incomes = R 596,233.24 x 15 % = R 89,434.99
Net benefit of project	Is the net income minus the tax payable = R 596,233.24 – R 89,434.99 = R 506,798.25
Return on investment	Is calculated by the net benefit of the project compared to the initial infrastructure costs expressed as a percentage.

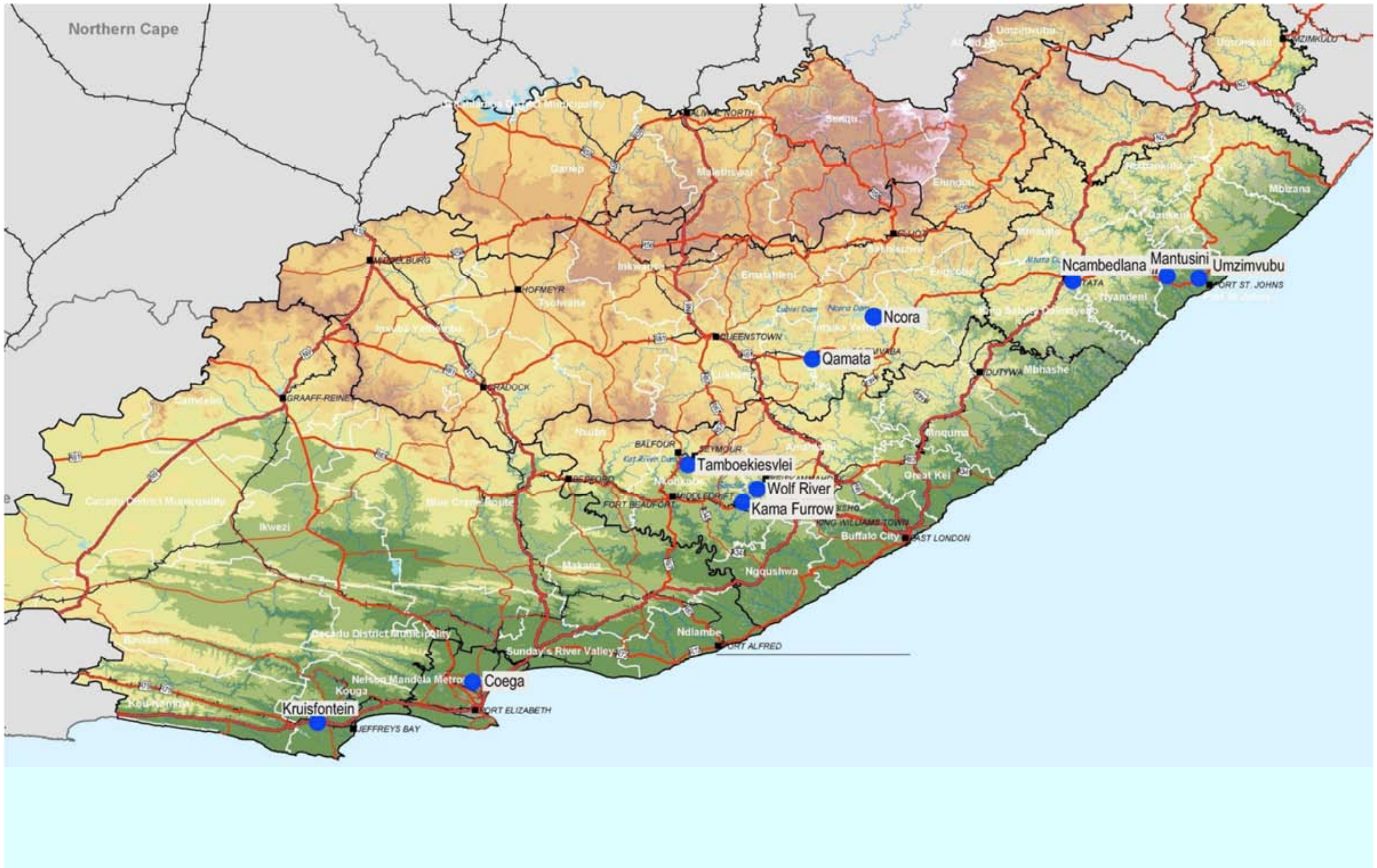
	= R 506,798.25 / R 673,633.51 x 100 / 1 = 75.23 % The cost of infrastructure from Appendix H of R 641,555.72 with a 5 % contingency of R 32,077.79 = R 673,633.51
Average total net income per ha	Is the net benefit of the project by the total hectares under irrigation. = R 506,798.25 / 20 ha = R 25,339.91
NPV	The NPV of the net benefit of project from year 1 to 20 with the discount rate of 8 %. The Net Present Value (NPV) is an indicator of how much value the investment adds. NPV calculates that present value for the series of cash flows from year 1 to 20 and adds them together to get the net present value. The discount rate is the rate which the capital needed for the project could return if invested in an alternative venture.

5 DATA COLLECTION

The field visits provided for physical investigation of the soils and positioning of the infrastructure layouts. There was additional numerical data collation for the hydrology and calculations of the available water for each scheme.

The background and summary of the hydrology and soil potential are presented in this section. The locality of each of these schemes is indicated on Figure 5-1.

Figure 5-1: Scheme location



5.1 Kruisfontein

5.1.1 Scheme location

Kruisfontein is located adjacent to the coastal town of Humansdorp, which is approximately 110 km south-west of Port Elizabeth and shown in Figure 5-1. The settlement comprises independent homesteads on approximately 1ha plots owned under title deeds.

5.1.2 Scheme background

The Kruisfontein “scheme” is a grouping of 32 homesteads of the more than 80 homesteads in the settlement each using up to 0.8 ha of their plots for market gardening under moisture-deficit flood irrigation. Food and animal production for home use, and for sale locally, is made possible by a water harvesting system linked to small dams and springs supplied by furrows to the individual plots on each separate homestead.

The minimal infrastructure at Kruisfontein was constructed in the 1950’s and is completed dilapidated, largely dysfunctional and in need of complete rehabilitation. The existing infrastructure comprises:

- Two small earth dams which rely on storm drainage for their water supply; that is, water-harvesting bunds, and have no continual inflow other than the springs that the settlement is named after (Kruisfontein). One dam is off-channel (“Dan se dam”), while the other is simply a bund constructed in a vlei area (Main Dam, also known as Klipwal).
- A number of small channels which convey water from the dams and from three or four springs (with names such as “Frank se Fontein”) amongst the plots. The sandy soils make these conveyance channels inefficient and present opportunities to make a sensible intervention.

5.1.3 Resource review

(a) Water availability

The yield of the two dams is 51,009 m^3 per annum at level of assurance of 80 %, based on the modelled cropping pattern. The total area that can be irrigated by the two dams is estimated at 7.41 ha for 9 members at commercial irrigation demands and 10.5 ha for 13 members at a reduced water demand.

The system from Frank se Fontein (continuous flow of 3.1 l/s) is hydraulically independent from the dams. Substantial night storage is available in the vlei area if the outlet works are designed to allow for ponding to a depth of 150 mm above the current top water level. This will allow for full use of the spring flows during daily irrigation draw-downs.
The total area that can be irrigated from Frank se Fontein is 11.8 ha for 14 farmers and 16.9 ha, equivalent to at least 21 farmers for a reduced demand.

Table 5-1: Available water, supplied areas and farmers for commercially based demands at Kruisfontein

Supply	Available Water (m^3/annum)	Irrigable Area that can be supplied (ha)	No. of Farmers that can be supplied
Dan se Dam, Klaas se Dam	51,009	7.41	9.26
Frank se Fontein	81,468	11.8	14.75
Total	132,477	19.21	24

Table 5-2: Available water, supplied areas and farmers for reduced demands at Kruisfontein

Supply	Available Water (m^3/annum)	Irrigable Area that can be supplied (ha)	No. of Farmers that can be supplied
Dan se Dam, Klaas se Dam	51,009	10.5	13.125
Frank se Fontein	81,468	16.9	21.13
Total	132,477	27.40	34

(b) Soils assessment

No soils assessment was undertaken as the farmers are actively irrigating the existing fields.

5.2 Tamboekiesvlei

5.2.1 Scheme location

The proposed Tamboekiesvlei Irrigation Scheme is situated in the Mpofu Magisterial District near Hertzog village, about 123 km from King Williams Town and shown in Figure 5-1.

5.2.2 Scheme background

The farm was expropriated in the 1980's for consolidation into the former Ciskei. The community was resettled at the time in the Klein Karoo and George areas. The farm is currently the subject of a land restitution claim. The claim has proved to be complicated in that there are descendants both of Commandant Groep as well as Xhosa occupiers. The Minister of Agriculture, during his term of office, gave permission to the claimants to reoccupy the land in mid 1995. There are approximately 400 claimants who are descendants of Commandant Groep.

The claim appears to be complex but the Regional Land Claims Commission is in the process of addressing this.

5.2.3 Resource review

Three storage capacities were modelled for a possible dam on the farm land. Initially, the yields associated with these capacities were calculated without taking any in-stream flow requirement (IFR) into account.

After modelling, the yield from the proposed Tamboekiesvlei dam on the farm itself is limiting, as it is only sufficient for 33.84 ha at reduced water demands and for 23.69 ha at commercial demands if placed under drip irrigation. The capacity of the dam is 42 000 m^3 or 0.05 % MAR.

5.3 Ncambedlana

5.3.1 Scheme location

The project is situated in the Eastern Cape Province 5km North of Mthatha. It is located in the Ncambendlana area of the King Sabata Dalindyebo Local Municipality (KSD LM) under the OR Tambo District Municipality and shown in Figure 5-1. The Philani Farmers Co-operative, located in the Ncambedlana area was started in June 2000.

5.3.2 Scheme background

The objective is to establish an irrigation scheme that will be used by the Philani Farmers Co-operative to supply water to the existing six hydroponic tunnels and in addition, to irrigate the unused fields in order to increase food production, create job opportunities locally and reduce poverty.

The co-operative has access to 16 hectares of irrigable land, but an area of up to 120 hectares could be included into a larger scheme to the benefit of a large number of other users, who are not part of the co-operative.

5.3.3 Resource review

(a) Water availability

The yield of Mthatha Dam at an assurance level of 80 % was calculated iteratively by varying the requirement defined for the irrigation abstraction channel until a 20 % failure rate was obtained (equivalent to a 1:5 year assurance level) (Table 5-3). Failure was defined to be the inability of the system to supply the full amount required for the abstraction.

Table 5-3: Demands on Mthatha Dam at 80 % assurance (x 10^6 m^3)

Demand	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
IFR	4.32	6.34	5.16	6.62	7.69	14.42	6	3.34	2.1	1.9	1.78	2.82	**62.5**
Domestic	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	**19**
Hydro-Power	6.08	6.08	6.08	6.08	6.08	6.08	6.08	6.08	6.08	6.08	6.08	6.08	**73**
Irrigation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Total	11.99	14.01	12.83	14.29	15.36	22.09	13.67	11.01	9.77	9.57	9.45	10.49	**154.50**

The yield of Mthatha Dam (accounting for present day development conditions as given in WR90) is estimated at 92 x 10^6 m^3 per annum with a level of assurance of 80 %.

With the current water allocations there is no water available for irrigation. Discussions with the majority user Eskom will be required for reallocation of water for irrigation to occur.

(b) Soils assessment

The soils in the survey area vary greatly as far as soil form/series classification, clay content in the sub-soil, effective depth and irrigation potential are concerned.

- Low potential (Non Irrigable) (63.7 hectares)
- Medium low potential (Irrigable with distinct limitations) (151.6 hectares)
- Medium potential (Irrigable) (95.1 hectares)

5.4 Wolf River

5.4.1 Scheme location

Wolf River is situated along the Keiskamma River, 2 km from the town of Keiskammahoek and 43 km from King Williams Town, shown in Figure 5-1. The area is situated alongside the Sandile Dam wall. The Wolf River irrigation scheme is essentially an undeveloped unit of the existing Zanyokwe irrigation scheme. Wolf River lies in the Amahlati Local Municipal area and falls within the Amatole District Municipality area of jurisdiction.

5.4.2 Scheme background

The Sandile pipeline runs from Sandile Dam through the greater Zanyokwe irrigation scheme and ends at Burnshill West. The Wolf River section of Zanyokwe scheme covers an area of 25 ha and has existing bulk irrigation infrastructure, but has only been partially developed infield. Wolf River is part of the Zanyokwe Water Users Association who are responsible for maintenance of the main pipeline.

An estimated 5 ha of this land, a communal garden with 14 members from the Wolf River village, is currently being irrigated under gravity. They are actively growing a range of vegetables, mostly cabbage, carrots, beetroot, butternut and green mealies. The remaining 20 ha of land is owned under title deeds and is lying fallow, unused for many years.

The need that emerged was an upgrade of the existing 20 ha of the Wolf River section of the Zanyokwe scheme which is privately owned, and has bulk water but no infield infrastructure.

5.4.3 Resource review

The yield of Sandile Dam at an assurance level of 80 % was calculated iteratively by varying the demand channel until a 20 % failure rate was obtained (equivalent to a 1:5 year assurance level). Failure was defined to be the inability of the system to supply the full amount required for the abstraction. The annual yield to supply with 80% assurance is 19.73 x 10^6 m^3. A similar procedure was followed for the 98 % assurance level and a yield of 13.06 x 10^6 m^3 per annum was obtained.

Table 5-4: Demands on Sandile Dam at 80 % assurance (x 10^6 m^3)

Demand	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
IFR	0.83	1.31	0.91	0.73	0.74	2.33	0.89	0.46	0.37	0.35	0.68	0.61	**10.2**
Domestic	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	**8.435**
Irrigation	1.60	1.94	2.28	0.91	0.34	1.14	1.26	0.80	0.00	0.00	0.23	0.80	**11.30**
Total	3.13	3.95	3.89	2.35	1.79	4.17	2.85	1.96	1.07	1.05	1.61	2.11	**29.93**

For the estimated 11.3 x 10^6 m^3 of water available for irrigation as indicated in Table 5-4, a total of 1200 ha can be irrigated. This area caters for the Zanyokwe (630 ha) and Rabula (43 ha) irrigation schemes with the residual area (527 ha) for run of river irrigation downstream along the Keiskamma River. The existing section of the Wolf River Scheme (25 ha) is included in the Zanyokwe Scheme.

5.5 Kama Furrow

5.5.1 Scheme location

Kama Furrow is an existing irrigation scheme situated on the banks of the Keiskamma River, 5 km from Middledrift, between King Williams Town and Alice and shown in Figure 5-1. The scheme was developed as part of Zanyokwe irrigation scheme in 1987, supplied with water from Sandile Dam on the Keiskamma River. Kama Furrow is semi-independent from the main irrigation scheme as it draws water from its own riverside pump station, but relies on river releases from the dam. The rest of Zanyokwe scheme is supplied from a piped water supply direct from Sandile Dam.

The Kama Furrow sub-scheme is situated in the Nkonkobe Local Municipality area, while the remainder of the Zanyokwe irrigation scheme lies in the Amahlati Local Municipal area. Both schemes fall within the Amathole District Municipality area of jurisdiction.

5.5.2 Scheme background

An estimated 51 ha of the available 60 ha at Kama Furrow is currently irrigated by electric pumps. The water is taken from the Keiskamma River and pumped to a storage reservoir from where it gravitates to the scheme.

The pumped bulk water supply could be converted to a gravity supply by extending the Sandile Pipeline, which supplies the rest of Zanyokwe scheme. This possibility to change from pumped to gravity supply is the main request for assistance from the Kama Furrow farmers.

5.5.3 Resource review

This scheme is fed by Sandile Dam which is discussed in detail in section 5.4.3.

5.6 Mantusini

5.6.1 Scheme location

The Mantusini Agricultural Farming Co-operative is situated in the Mantusini area in the Eastern Cape Province, which is 12 km north of Port St Johns and shown in Figure 5-1. The project lies about 7 km west of the R61 road from Mthatha to Port St Johns.

5.6.2 Scheme background

The arable land is communally owned by 570 resident families and lies along the Mngazi River. The estimated total area of arable land is approximately 350 ha. Sections of this area would, however, have to be excluded due to poor drainage causing waterlogging. The Department of Agriculture (DoA) has assisted the project participants to form a co-operative of about 200 members and it is in the process of being registered. Some of the areas have been fenced off in order to enable community members to become involved in more intensive agricultural production on a dry-land basis.

5.6.3 Resource review

(a) Water availability

It can be seen from Table 5-5, that there is substantial water available for irrigation at 80 % exceedence probability, in the order of 170,000 to 640,000 m^3 per month for most months, with the exception of March. The typical irrigation demands are based on crop water requirements for smallholder farmers (reduced demands) and it is reasonable to conclude that total irrigation on the Mngazi should not exceed a maximum of 150 ha, before reliability becomes a major limiting factor.

Table 5-5: Natural flow minus IFR requirement at 80 % exceedence probability (x 10^6 m^3) at Abstraction for Mantusini

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Natural	1.21	1.35	0.91	0.76	0.87	1.22	1.31	1.2	0.95	0.88	0.87	1.02	**12.55**
IFR	0.74	1.03	0.74	0.54	0.59	1.22	0.96	0.56	0.4	0.41	0.4	0.57	**8.16**
Availability	0.47	0.32	0.17	0.22	0.28	0	0.35	0.64	0.54	0.47	0.47	0.45	**4.38**
Typical Irri-demand (30ha)	0.022	0.019	0.032	0.014	0.002	0.013	0.024	0.014	0.000	0.000	0.006	0.007	**0.154**
Typical Irri demand (150ha)	0.109	0.093	0.161	0.071	0.010	0.067	0.120	0.072	0.000	0.000	0.030	0.035	**0.768**

The results of the IFR requirement for the catchment indicates that in situations it is equal to the natural flow.

Although these figures show that there is no available water, the IFR quantities are preliminary, and therefore possibly conservative. It is recommended that the ecological reserve requirement be re-assessed in detail before any major investment in irrigation is made.

Using the residual flows from Table 5-5, the possible area that can be irrigated was calculated. Since no abstraction will be available during March, cropping periods will be selected to maximise the flows in the other months. The next limiting month is December and this has been used to estimate the possible area. For summer crops with peaks in December the maximum area that can be irrigated are 150 ha. A greater potential area is available to be irrigated in winter from April to August where the greatest residual flow is available. The soils at Mantusini are, however, limiting and even though there is sufficient water for 150 ha, the land is not suitable. A smaller scheme based on the available soils would be in the order of 30 ha.

(b) Soils assessment

The soils in the survey area vary greatly as far as soil form/series classification, clay content in the sub-soil, effective depth and irrigation potential are concerned.

- Low potential (Non Irrigable) (27 hectares)
- Medium low potential (Irrigable with distinct limitations) (101.5 hectares)
- Medium potential (Irrigable) (11.8 hectares)

5.7 Summary

The resource evaluation provides the critical framework for a successful irrigation scheme. Without sufficient water and suitable land the project will be limited as shown in the previous sections. The area for development determined from the available water and land areas directs the design area. The evaluation of the crop water requirements and engineering infrastructure will be discussed in the next section.

6 EVALUATION

For the evaluation, a complete design for each scheme was done. This included different implementation options for the two levels of supply.

The design process included the calculation of the crop water requirements and determination of the peak month. The peak month was then used for the design process in ensuring that there is sufficient supply at any time of year.

The infrastructure was then sized using the peak month flows and incorporated into possible cycle operations. The correct sizing of the system was then done and the associated capital and O&M costs could be calculated.

Each scheme has been presented separately with the corresponding water demands and system capacities for the two farmer types.

The detailed capital cost breakdowns for the two LOS are attached in Appendix H and I. The calculations for the O&M costs for each LOS are attached in Appendix J and K.

6.1 Kruisfontein scheme

6.1.1 Water requirements for crops

Water requirements for the crop patterns were calculated using the SAPWAT software released by the Water Research Commission (Crosby, 1999) as presented in Table 6-1 for commercially based water demands, and Table 6-3 for reduced water demand. The associated gross demand is presented in Table 6-2 and Table 6-4 for the two cases respectively.

Table 6-1: Gross crop water requirements for commercially based demands at Kruisfontein

Month	Typical fresh vegetables - summer crop			Dry maize - summer crop			Typical fresh vegetables - winter crop			Total
	mm/ha	ha	m^3/ annum	mm/ha	ha	m^3/ annum	mm/ha	ha	m^3/ annum	m^3/ annum
Jan	199.2	15.37	30,613	92	3.84	3,535				34,148
Feb										
March							68.8	6.34	4,361	4,361
April							82.4	6.34	5,224	5,224
May							96.8	6.34	6,136	6,136
June							70.4	6.34	4,463	4,463
July							14.4	6.34	913	913
Aug										
Sep				32	3.84	1,229				1,229
Oct	54.4	15.37	8,360	96	3.84	3,688				12,049
Nov	137.6	15.37	21,146	170.4	3.84	6,547				27,693
Dec	185.6	15.37	28,523	195.2	3.84	7,500				36,023
Total	**576.8**		**88,643**	**585.6**		**22,499**	**332.8**		**21,097**	**132,239**

Table 6-2: Gross monthly water requirements per water source for commercially based demands at Kruisfontein

Month	Monthly demand (m^3) Dan se Dam, Klaas se Dam (9 Farmers)	Monthly demand (m^3) Frank se Fontein (14 Farmers)	Total monthly demand (m^3)
Jan	13,362	20,786	34,148
Feb	0	0	0
March	1,707	2,655	4,361
April	2,044	3,180	5,224
May	2,401	3,735	6,136
June	1,746	2,717	4,463
July	357	556	913
Aug	0	0	0
Sep	481	748	1,229
Oct	4,715	7,334	12,049
Nov	10,836	16,857	27,693
Dec	14,096	21,927	36,023
Total	**51,746**	**80,493**	**132,239**

Table 6-3: Gross crop water requirements for reduced demands at Kruisfontein

Month	Typical fresh vegetables - summer crop			Dry maize - summer crop			Typical fresh vegetables - winter crop			Total
	mm/ha	ha	m^3/annum	mm/ha	ha	m^3/ annum	mm/ha	ha	m^3/ annum	m^3/ annum
Jan	139.44	15.37	21,429	64.4	3.84	2,474				23,903
Feb										
March							48.16	6.34	3,053	3,053
April							57.68	6.34	3,657	3,657
May							67.76	6.34	4,296	4,296
June							49.28	6.34	3,124	3,124
July							10.08	6.34	639	639
Aug										
Sep				22.4	3.84	861				861
Oct	38.08	15.37	5,852	67.2	3.84	2,582				8,434
Nov	96.32	15.37	14,802	119.28	3.84	4,583				19,385
Dec	129.92	15.37	19,966	136.64	3.84	5,250				25,216
Total	**403.76**		**62,050**	**409.92**		**15,749**	**232.96**		**14,768**	**92,567**

Table 6-4: Gross monthly water requirements per water resource for reduced demands at Kruisfontein

Month	Monthly demand (m^3) Dan se Dam, Klaas se Dam (9 Farmers)	Monthly demand (m^3) Frank se Fontein (14 Farmers)	Total monthly demand (m^3)
Jan	9,353	14,550	23,903
Feb	0	0	0
March	1,195	1,858	3,053
April	1,431	2,226	3,657
May	1,681	2,615	4,296
June	1,222	1,902	3,124
July	250	389	639
Aug	0	0	0
Sep	337	524	861
Oct	3,300	5,134	8,434
Nov	7,586	11,800	19,385
Dec	9,867	15,349	25,216
Total	**36,222**	**56,345**	**92,567**

6.1.2 Proposed infrastructure

The proposed engineering design maintains the current grouping of farmers based on the three water sources. However, the two dams are interlinked hydraulically (Dan se Dam flows over into Klaas se Dam) so these two have operational links that will have some impact on management.

The group from Frank se Fontein will be hydraulically separate from the two groups supplied by the dams. This is not technically required, but is the solution preferred by the members and will maintain the current methods of water apportionment and grouping around water sources.

The rehabilitation design includes the following:

- The existing dams will be rehabilitated with cleaning of Klaas se Dam (reeds and black wattle), the reconstruction of the spillways and installation of sluice gates and outlet pipes. The inlet to Dan se Dam channelling surface runoff needs formalisation as it is a temporary structure.

- A new, piped distribution system will replace the existing earth furrows. It will be constructed from both dams to provide water to members of the Grondwerkers Forum.

- The piped distribution system will be a 24 hour constant flow system supplying ground-level storage tanks at each member's land. The flow will be sufficient for the maximum daily requirement for each farmer based on the demand estimated by observation and calculation at Frank se Fontein.

- A flow control valve will be used at each tank to enable an equal distribution of flow, to allow for equal apportionment. The tanks will also be used for harvesting rainwater from roof runoff to augment the supply.

- At Frank se Fontein, four members at the lowest elevations will be supplied by the piped system with tanks. However, there are eight members at an elevation that cannot be supplied by a piped system. In these cases, concrete lined channels will be used to distribute the flow. A small diversion box will be required at each point of supply.

The construction requirements for the two options are given below. The development options are shown in drawings B1 and B2.

The schematic layout of the scheme is shown in Figure 6-1.

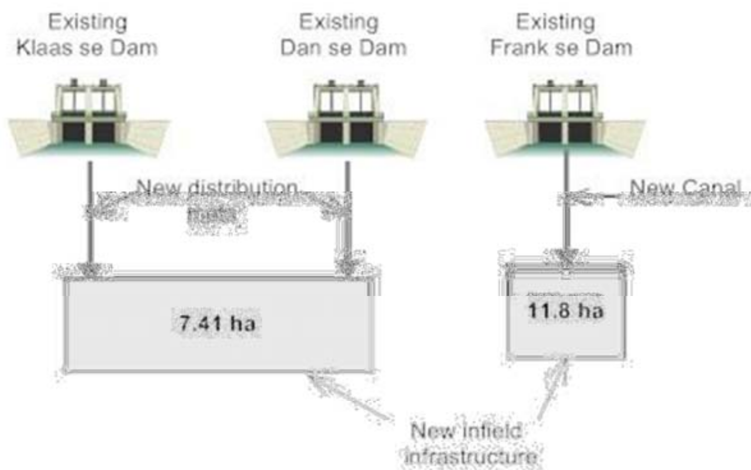
(a) Commercially based option

- Remedial work on existing dams;
- 609 m of concrete lined channels and diversion boxes; and
- 3 995 m of HDPE pipe work (160 mm – 40 mm diameter).

(b) Smallholder irrigator based option

- Remedial work on existing dams;
- 609 m of concrete lined channels and diversion boxes; and
- 4 022 m of HDPE pipe work (90 mm – 40 mm diameter).

Figure 6-1: Schematic layout of Kruisfontein



6.1.3 Scheme cost

(a) Commercially based option

The capital and operational costs for the commercially based option are presented in Table 6-5 and Table 6-6 respectively, based on 2007 costs.

Table 6-5: Construction costs of commercial option at Kruisfontein

Item	Amount (R excl VAT) (Base year 2007)
Dams	41,250.00
Channels	32,043.75
Pipelines	479,771.53
Construction total	553,065.28
Design & supervision fees - 16%	88,490.44
Total	**641,555.72**

Table 6-6: Operations and maintenance costs of commercial option at Kruisfontein

Item	Amount (R excl VAT) (Base year 2007)
Civil	3,207.78
M&E	0.00
Energy – Eskom	0.00
Water charges	886.00
Total	**4,093.78**

The ongoing annual operations and maintenance costs for running the scheme at its designed level include normal maintenance costs of the infrastructure and the ongoing water charges.

(b) Smallholder irrigator based option

The capital and operational costs for the smallholder irrigator option are presented in Table 6-7 and Table 6-8 respectively, based on 2007 costs.

Table 6-7: Construction costs of smallholder option at Kruisfontein

Item	Amount (R excl VAT) (Base year 2007)
Dams	41,250.00
Channels	32,043.75
Pipelines	315,633.03
Construction total	388,926.78
Design & supervision fees - 16%	62,228.28
Total	**451,155.06**

Table 6-8: Operations and maintenance costs of smallholder option at Kruisfontein

Item	Amount (R excl VAT) (Base year 2007)
Civil	2,255.78
M&E	0.00
Energy – Eskom	0.00
Water charges	620.20
Total	**2,875.97**

The ongoing annual operations and maintenance costs for running the scheme at its designed level include normal maintenance costs of the infrastructure and the ongoing water charges.

(c) Commercial underutilised option

The capital for the commercial design option is the same as illustrated in Table 6-5. The operational costs of the smallholder irrigator on the commercial designed system are shown in Table 6-9, based on 2007 costs.

Table 6-9: Operations and maintenance costs of commercial underutilised option at Kruisfontein

Item	Amount (R excl VAT) (Base year 2007)
Civil	3,207.78
M&E	0.00
Energy – Eskom	0.00
Water charges	620.20
Total	**3,827.98**

6.2 Tamboekiesvlei scheme

6.2.1 Water requirements for crops

Water requirements for the crop patterns were calculated using the SAPWAT software released by the Water Research Commission (Crosby, 1999) as presented in Table 6-10 for commercially based water demands, and Table 6-11 for reduced water demand.

Table 6-10: Gross crop water requirements for commercially based demands at Tamboekiesvlei

Month	Typical fresh vegetables - summer crop			Dry maize - summer crop			Typical fresh vegetables - winter crop			Total
	mm/ha	ha	m^3/annum	mm/ha	ha	m^3/annum	mm/ha	ha	m^3/ annum	m^3/annum
Jan	195	27.07	52,790	121	6.77	8,178				60,968
Feb										
March							83.3	11.17	9,306	9,306
April							110	11.17	12,284	12,284
May							135	11.17	15,076	15,076
June							113.3	11.17	12,656	12,656
July							21.7	11.17	2,420	2,420
Aug										
Sep				72	6.77	4,850				4,850
Oct	61	27.07	16,469	132	6.77	8,911				25,380
Nov	153	27.07	41,510	236	6.77	15,961				57,472
Dec	199	27.07	53,918	289	6.77	19,571				73,489
Total	**608**		**164,688**	**849**		**57,472**	**463**		**51,741**	**273,901**

Table 6-11: Gross crop water requirements for reduced demands at Tamboekiesvlei

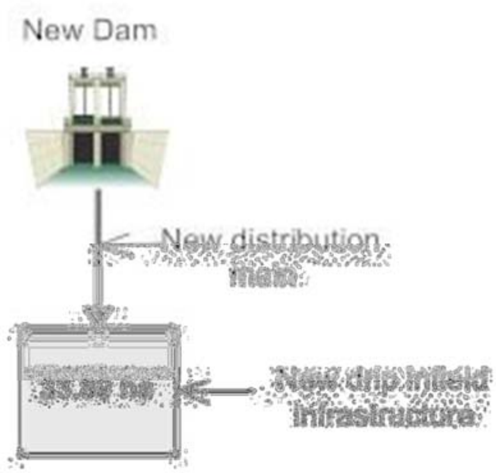
Month	Typical fresh vegetables - summer crop			Dry maize - summer crop			Typical fresh vegetables - winter crop			Total
	mm/ha	ha	m^3/annum	mm/ha	ha	m^3/annum	mm/ha	ha	m^3/ annum	m^3/annum
Jan	137	27.07	36,953	85	6.77	5,725				42,678
Feb										
March							58	11.17	6,514	6,514
April							77	11.17	8,599	8,599
May							95	11.17	10,553	10,553
June							79	11.17	8,859	8,859
July							15	11.17	1,694	1,694
Aug										
Sep				50	6.77	3,395				3,395
Oct	43	27.07	11,528	92	6.77	6,238				17,766
Nov	107	27.07	29,057	165	6.77	11,173				40,230
Dec	139	27.07	37,743	202	6.77	13,700				51,442
Total	**426**		**115,282**	**594**		**40,230**	**324**		**36,219**	**191,731**

6.2.2 Proposed infrastructure for primary option

The scheme will rely on the runoff that will be generated in the catchment above the lands. A small earth dam can be constructed to allow sufficient water during the irrigation season. A bulk line from the dam will supply the infield area at the field edge. The land selected for irrigation can be fed by gravity if located in the most down-sloping portion, thus avoiding pumps and related operational complexity and costs.

The schematic layout of the scheme is shown in Figure 6-2.

Figure 6-2: Schematic layout of Tamboekiesvlei



(a) Commercially based option

The scheme will require a reservoir capacity of 82 000 m^3. An 8 m high wall, designed to allow for future raising, will increase the area that can be irrigated. Next, 33.84 ha will be provided with a drip irrigation system that has been selected given the critical need for a water efficient system. The proposed infrastructure is summarised below and is shown in drawing C1:

- Construction of 82 000 m^3 dam;
- Distribution main, 250 mm diameter; and
- Drip irrigation infield for 33.89 ha.

(b) Smallholder irrigator based option

The scheme will require a reservoir capacity of 42 000 m^3. The 6.5 m high wall will be designed to allow for future raising that will increase the area that can thereafter be irrigated. The irrigable area of 33.84 ha will be installed with a drip irrigation system that has been selected given the critical need for a water efficient system. The proposed infrastructure is summarised below and is shown in drawing C2:

- Construction of 42 000 m^3 dam;
- Distribution main, 200 mm diam; and

- Drip irrigation infield for 33.84 ha.

6.2.3 Scheme cost

(a) Commercially based option

The capital and operational costs for the commercially based option are presented in Table 6-12 and Table 6-13 respectively, based on 2007 costs.

Table 6-12: Construction costs of proposed infrastructure for commercial irrigators at Tamboekiesvlei

Item	Amount (R excl VAT) (Base year 2007)
Dam	2,323,086.96
Outlet works from dam	37,500.00
Pipelines	1,425,661.96
Infield	761,400.00
Construction total	4,547,648.91
Design & supervision fees - 16%	727,623.83
Total	**5,275,272.74**

Table 6-13: Operations and maintenance costs of proposed infrastructure for commercial irrigators at Tamboekiesvlei

Item	Amount (R excl VAT) (Base year 2007)
Civil	19,639.41
M&E	0.00
Energy – Eskom	0.00
Water charges	1,835.14
Total	**21,474.55**

The ongoing annual operations and maintenance costs for running the scheme at its designed level include normal maintenance costs of the infrastructure and the ongoing water charges.

(b) Smallholder irrigator based option

The capital and operational costs for the smallholder irrigator option are presented in Table 6-14 and Table 6-15 respectively, based on 2007 costs.

Table 6-14: Construction costs of proposed infrastructure for smallholder irrigators at Tamboekiesvlei

Item	Amount (R excl VAT) (Base year 2007)
Dam	1,327,042.93
Outlet works from dam	37,500.00
Pipelines	893,060.11
Infield	761,400.00
Construction total	3,019,003.04
Design & supervision fees - 16%	483,040.49
Total	**3,502,043.53**

Table 6-15: Operations and maintenance costs of proposed infrastructure for smallholder irrigators at Tamboekiesvlei

Item	Amount (R excl VAT) (Base year 2007)
Civil	13,661.79
M&E	0.00
Energy – Eskom	0.00
Water charges	1,284.60
Total	**14,946.39**

The ongoing annual operations and maintenance costs for running the scheme at its designed level include normal maintenance costs of the infrastructure and the ongoing water charges.

(c) Commercial underutilised option

The capital for the commercial design option is the same as illustrated in Table 6-13. The operational costs of the smallholder irrigator on the commercial designed system are shown in Table 6-16, based on 2007 costs.

Table 6-16: Operations and maintenance costs of commercial underutilised option at Tamboekiesvlei

Item	Amount (R excl VAT) (Base year 2007)
Civil	19,639.41
M&E	0.00
Energy – Eskom	0.00
Water charges	1,284.60
Total	**20,924.01**

6.3 Ncambedlana scheme

6.3.1 Water requirements for crops

Water requirements for the crop patterns were calculated using the SAPWAT software released by the Water Research Commission (Crosby, 1999) as presented in Table 6-17 for commercially based water demands, and Table 6-18 for reduced water demand.

Table 6-17: Gross crop water requirements for commercially based demands at Ncambedlana

Month	Typical fresh vegetables - summer crop			Dry maize - summer crop			Typical fresh vegetables - winter crop			Total
	mm/ha	ha	m^3/annum	mm/ha	ha	m^3/annum	mm/ha	ha	m^3/annum	m^3/annum
Jan	185.9	68	126,412	88.4	17	15,028				141,440
Feb										0
March							19.5	28.05	5,470	5,470
April							89.7	28.05	25,161	25,161
May							100.1	28.05	28,078	28,078
June							91	28.05	25,526	25,526
July							20.8	28.05	5,834	5,834
Aug										0
Sep				48.1	17	8,177				8,177
Oct	59.8	68	40,664	128.7	17	21,879				62,543
Nov	162.5	68	110,500	211.9	17	36,023				146,523
Dec	201.5	68	137,020	214.5	17	36,465				173,485
Total	**609.7**		**414,596**	**691.6**		**117,572**	**321.1**		**90,069**	**622,237**

Table 6-18: Gross crop water requirements for reduced demands at Ncambedlana

Month	Typical fresh vegetables - summer crop			Dry maize - summer crop			Typical fresh vegetables - winter crop			Total
	mm/ha	ha	m^3/annum	mm/ha	ha	m^3/annum	mm/ha	ha	m^3/annum	m^3/annum
Jan	130.13	68	88,488	61.88	17	10,520				99,008
Feb										0
March							13.65	28.05	3,829	3,829
April							62.79	28.05	17,613	17,613
May							70.07	28.05	19,655	19,655
June							63.7	28.05	17,868	17,868
July							14.56	28.05	4,084	4,084
Aug										0
Sep				33.67	17	5,724				5,724
Oct	41.86	68	28,465	90.09	17	15,315				43,780
Nov	113.75	68	77,350	148.33	17	25,216				102,566
Dec	141.05	68	95,914	150.15	17	25,526				121,440
Total	**426.79**		**290,217**	**484.12**		**82,300**	**224.77**		**63,048**	**435,566**

It is important to note that there is potential water use conflict for irrigation demands. This is linked to the current utilisation of Mthatha Dam, and irrigation at Ncambedlana would require negotiation with the major water user, that is, Eskom, amongst others.

6.3.2 Proposed infrastructure for primary option

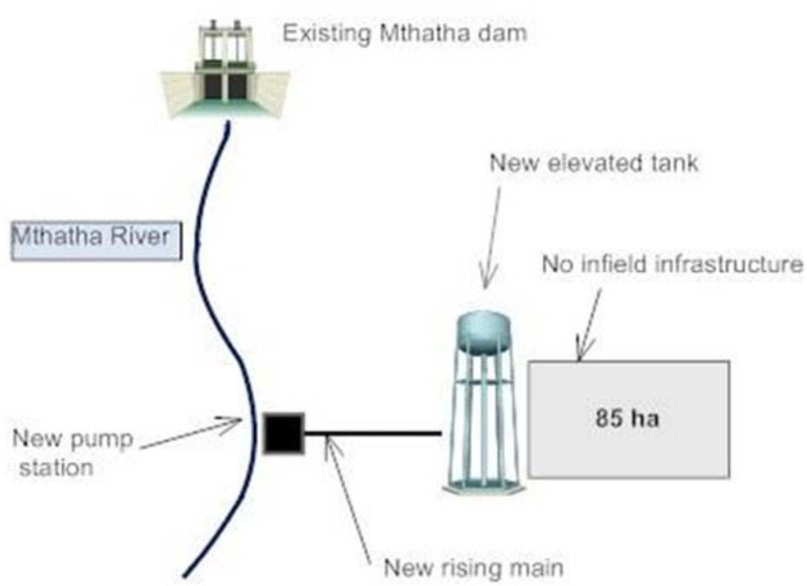
The proposed option will involve the construction of a pumped intake works on the Mthatha River, feeding a rising main to a 25 m elevated tank at a central position within Ncambedlana East. The initial installation will be sufficient to supply an area of 85 ha of water. Should this be a success, there is opportunity to duplicate the system to increase the area supplied as required in subsequent phases.

Suitable intakes on the banks of the Mthatha River are available for the construction of a pump station. The system has been sized to allow for some flexibility in the demand requirements. The irrigation cycle of the farmers is likely to be such that each will irrigate in a manner that is not rigidly set to 8 hours over the same period each day.

The elevated tank was sized for a 10 minute pumping cycle for the peak irrigation period. This then limits the number of starts at the pump station to 6 starts per hour. While more storage would be desirable to accommodate operational down time of the pump station, this is an expensive component of the system and has been minimised accordingly. The proposed infrastructure can be summarised below:

The schematic layout of the scheme is shown in Figure 6-3.

Figure 6-3: Schematic layout of Ncambedlana



(a) Commercially based option

The proposed infrastructure is summarised below and is shown in drawing D1:

- An Eskom connection;
- Pump station with diversion works on Mthatha River (276.09 l/s);

- 500 mm diameter steel rising main 1050 m in length; and
- 150 m^3 elevated tank.

(b) Smallholder irrigator based option

The proposed infrastructure is summarised below and is shown in drawing D2:

- An Eskom connection;
- Pump station with diversion works on Mthatha River (202.9 l/s);
- 450 mm diameter steel rising main 1050 m in length; and
- 110 m^3 elevated tank.

6.3.3 Scheme cost

(a) Commercially based option

The capital and operational costs for the commercially based option are presented in Table 6-19 and Table 6-20 respectively, based on 2007 costs.

Table 6-19: Construction costs of commercial irrigators at Ncambedlana

Item	**Amount (R excl VAT) (Base year 2007)**
Diversion works	156,250.00
Pump station	2,233,369.57
Pipelines	2,710,874.24
Elevated tank	1,444,687.50
Construction total	9,297,056.31
Design & supervision fees - 16%	1,487,529.01
Total	**10,784,585.32**

Table 6-20: Annual operation and maintenance costs of commercial irrigators at Ncambedlana

Item	**Amount (R excl VAT) per annum(Base year 2007)**
Civil	40,969.38
M&E	103,628.35
Energy – Eskom	827,364.69
Water charges	25,418.98
Total	**997,381.40**

The ongoing annual operations and maintenance costs for running the scheme at its designed level include normal maintenance costs of the infrastructure and the ongoing water charges.

(b) Smallholder irrigator based option

The capital and operational costs for the smallholder irrigator option are presented in Table 6-21 and Table 6-22 respectively, based on 2007 costs.

Table 6-21: Construction costs of smallholder irrigator option at Ncambedlana

Item	Amount (R excl VAT) (Base year 2007)
Diversion works	156,250.00
Pump station	1,638,864.13
Pipelines	2,425,868.27
Elevated tank	1,279,375.00
Construction total	7,965,357.40
Design & supervision fees - 16%	1,274,457.18
Total	**9,239,814.59**

Table 6-22: Annual operation and maintenance costs of smallholder irrigator option at Ncambedlana

Item	Amount (R excl VAT) per annum(Base year 2007)
Civil	36,693.66
M&E	76,043.30
Energy – Eskom	505,140.53
Water charges	24,168.29
Total	**642,045.77**

The ongoing annual operations and maintenance costs for running the scheme at its designed level include normal maintenance costs of the infrastructure and the ongoing water charges.

(c) Commercial underutilised option

The capital for the commercial design option is the same as illustrated in Table 6-19. The operational costs of the smallholder irrigator on the commercial designed system are shown in Table 6-23, based on 2007 costs.

Table 6-23: Operations and maintenance costs of commercial underutilised option at Ncambedlana

Item	Amount (R excl VAT) (Base year 2007)
Civil	40,969.38
M&E	103,628.35
Energy – Eskom	715,965.60
Water charges	24,168.29
Total	**884,731.62**

6.4 Wolf River scheme

6.4.1 Water requirements for crops

Water requirements for the crop patterns were calculated using the SAPWAT software released by the Water Research Commission (Crosby, 1999) as presented in Table 6-24 for commercially based water demands, and Table 6-25 for reduced water demand.

Table 6-24: Gross crop water requirements for commercially based demands at Wolf River

Month	Typical fresh vegetables - summer crop			Dry maize - summer crop			Typical fresh vegetables - winter crop			Total
	mm/ha	ha	m³/annum	mm/ha	ha	m³/annum	mm/ha	ha	m³/annum	m³/annum
Jan	234	20	46,800	9	5	450				47,250
Feb										
March							70	8.25	5,775	5,775
April							96	8.25	7,920	7,920
May							116	8.25	9,570	9,570
June							93	8.25	7,673	7,673
July							20	8.25	1,650	1,650
Aug										
Sep				69	5	3,450				3,450
Oct	73	20	14,600	132	5	6,600				21,200
Nov	184	20	36,800	230	5	11,500				48,300
Dec	239	20	47,800	252	5	12,600				60,400
Total	**730**		**146,000**	**692**		**34,600**	**395**		**32,588**	**213,188**

Table 6-25: Gross crop water requirements for reduced demands at Wolf River

Month	Typical fresh vegetables - summer crop			Dry maize - summer crop			Typical fresh vegetables - winter crop			Total
	mm/ha	ha	m³/annum	mm/ha	ha	m³/annum	mm/ha	ha	m³/annum	m³/annum
Jan	163.8	20	32,760	6.3	5	315				33,075
Feb										
March							49	8.25	4,043	4,043
April							67.2	8.25	5,544	5,544
May							81.2	8.25	6,699	6,699
June							65.1	8.25	5,371	5,371
July							14	8.25	1,155	1,155
Aug										
Sep				48.3	5	2,415				2,415
Oct	51.1	20	10,220	92.4	5	4,620				14,840
Nov	128.8	20	25,760	161	5	8,050				33,810
Dec	167.3	20	33,460	176.4	5	8,820				42,280
Total	**511**		**102,200**	**484.4**		**24,220**	**276.5**		**22,811**	**149,231**

6.4.2 Proposed infrastructure for primary option

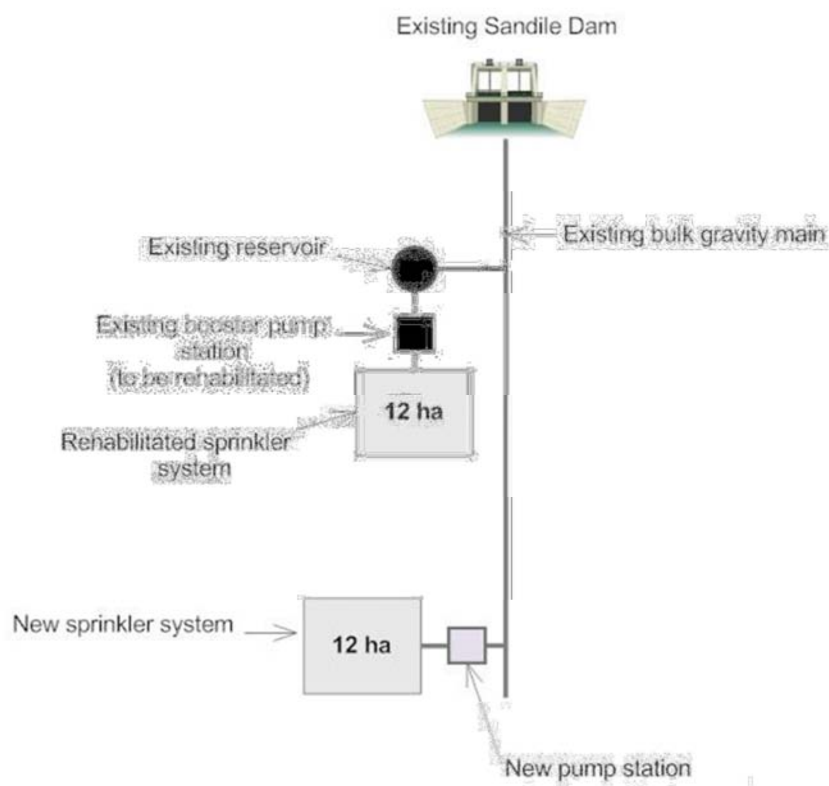
The Wolf River "scheme" is a portion of the Zanyokwe Irrigation Scheme, with two sections of irrigable land identified. Two areas have existing infrastructure, being closest to the dam. The second area, further from the dam, requires the entire necessary infrastructure for irrigation to take place. The area closest to the dam requires refurbishment of the infrastructure to bring it back to optimal condition. Distribution mains, booster pumps and infield infrastructure will have to be constructed for the area farthest from the dam.

The refurbishment of the scheme involves the repair of the outlet booster pump station, Eskom connections and replacement of portions of the above ground infield system. The landowners also requested assistance with the fencing of the lands. The infrastructure has been listed below and shown in drawing E1.

- Booster Pump Station;
- 2x Eskom connections;
- Replacement of necessary portions of infield equipment for 12 ha;
- New infield equipment for 12 ha; and
- Fencing of the area, 3 250 m.

The schematic layout of the scheme is shown in Figure 6-4.

Figure 6-4: Schematic layout of Wolf River



6.4.3 Scheme cost

(a) Commercially based option

The capital and operational costs for the commercially based option are presented in Table 6-26 and Table 6-27 respectively, based on 2007 costs.

Table 6-26: Construction costs to refurbish Wolf River sub-scheme for commercial irrigators

Item	Amount (R excl VAT) (Base year 2007)
Booster pump station	110,000.00
Fencing	406,250.00
Infield	432,608.07
Construction total	948,858.07
Design & supervision fees - 16%	151,817.29
Total	**1,100,675.36**

Table 6-27: Operations and maintenance costs of Wolf River sub-scheme for commercial irrigators

Item	Amount (R excl VAT) (Base year 2007)
Civil	19,137.88
M&E	3,900.00
Energy – Eskom	32,459.62
Water charges	7,678.36
Total	**63,175.85**

The ongoing annual operations and maintenance costs for running the scheme at its designed level include normal maintenance costs of the infrastructure and the ongoing water charges.

(b) Smallholder irrigator based option

The capital and operational costs for the smallholder irrigator option are presented in Table 6-28 and Table 6-29 respectively, based on 2007 costs.

Table 6-28: Construction costs to refurbish Wolf River sub-scheme for smallholder irrigators

Item	Amount (R excl VAT) (Base year 2007)
Booster pump station	91,250.00
Fencing	406,250.00
Infield	417,000.00
Construction total	914,500.00
Design & supervision fees - 16%	146,320.00
Total	**1,060,820.00**

Table 6-29: Operations and maintenance costs of Wolf River sub-scheme for smallholder irrigators

Item	Amount (R excl VAT) (Base year 2007)
Civil	18,970.48
M&E	3,150.00
Energy – Eskom	24,534.12
Water charges	7,249.85
Total	**53,904.45**

The ongoing annual operations and maintenance costs for running the scheme at its designed level include normal maintenance costs of the infrastructure and the ongoing water charges.

(c) Commercial underutilised option

The capital for the commercial design option is the same as illustrated in Table 6-26. The operational costs of the smallholder irrigator on the commercial designed system are shown in Table 6-30, based on 2007 costs.

Table 6-30: Operations and maintenance costs of Wolf River sub-scheme for commercial underutilised option

Item	Amount (R excl VAT) (Base year 2007)
Civil	19,047.35
M&E	3,900.00
Energy – Eskom	30,419.08
Water charges	7,249.85
Total	**60,616.28**

6.5 Kama Furrow Scheme

6.5.1 Water requirements for crops

Water requirements for the crop patterns were calculated using the SAPWAT software released by the Water Research Commission (Crosby, 1999) as presented in Table 6-31 for commercially based water demands, and Table 6-32 for reduced water demand.

Table 6-31: Gross crop water requirements for commercially based demands at Kama Furrow

Month	Typical fresh vegetables - summer crop			Dry maize - summer crop			Typical fresh vegetables - winter crop			Total
	mm/ha	ha	m^3/annum	mm/ha	ha	m^3/annum	mm/ha	ha	m^3/annum	m^3/annum
Jan	234	40.64	95,098	109	10.16	11,074				106,172
Feb										0
March							70	16.76	11,735	11,735
April							96	16.76	16,093	16,093
May							116	16.76	19,446	19,446
June							93	16.76	15,591	15,591
July							20	16.76	3,353	3,353
Aug										0
Sep				69	10.16	7,010				7,010
Oct	73	40.64	29,667	132	10.16	13,411				43,078
Nov	184	40.64	74,778	230	10.16	23,368				98,146
Dec	239	40.64	97,130	252	10.16	25,603				122,733
Total	**730**		**296,672**	**792**		**80,467**	**395**		**66,218**	**443,357**

Table 6-32 : Gross crop water requirements for reduced demands at Kama Furrow

Month	Typical fresh vegetables - summer crop			Dry maize - summer crop			Typical fresh vegetables - winter crop			Total
	mm/ha	ha	m^3/annum	mm/ha	ha	m^3/annum	mm/ha	ha	m^3/annum	m^3/annum
Jan	163.8	40.64	66,568	76.3	10.16	7,752				74,320
Feb										0
March							49	16.76	8,214	8,214
April							67.2	16.76	11,265	11,265
May							81.2	16.76	13,612	13,612
June							65.1	16.76	10,913	10,913
July							14	16.76	2,347	2,347
Aug										0
Sep				48.3	10.16	4,907				4,907
Oct	51.1	40.64	20,767	92.4	10.16	9,388				30,155
Nov	128.8	40.64	52,344	161	10.16	16,358				68,702
Dec	167.3	40.64	67,991	176.4	10.16	17,922				85,913
Total	**511**		**207,670**	**554.4**		**56,327**	**276.5**		**46,352**	**310,350**

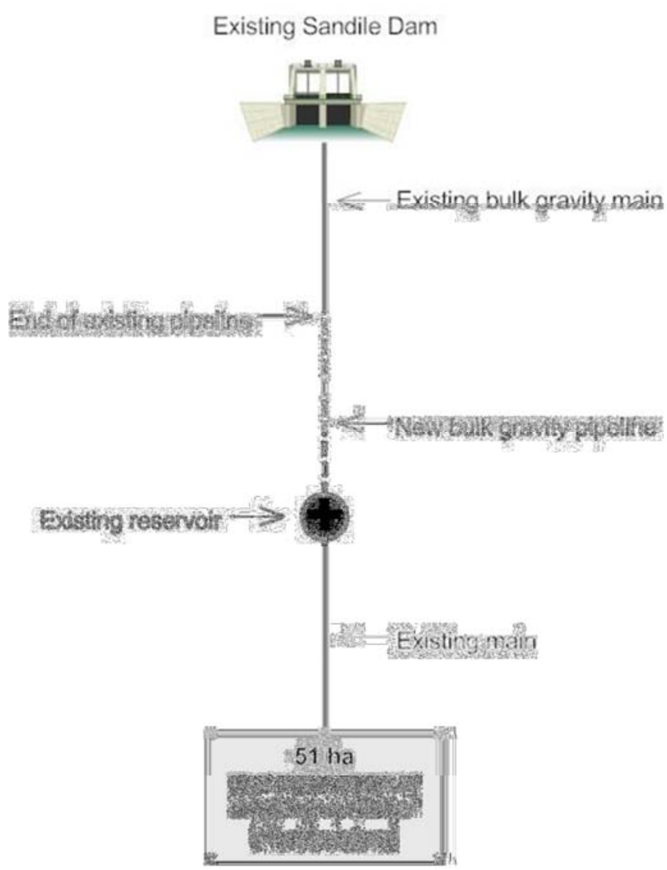
6.5.2 Proposed infrastructure for primary option

The existing bulk pipeline that feeds the Zanyokwe scheme from Sandile Dam ends at Burnshill, some 5 km upstream of Kama Furrow. This pipeline can be extended to serve the Kama Furrow sub-scheme with no impact on the original design limitations of the Zanyokwe scheme. No additional water will be drawn off the dam, as it will be transferred to Kama Furrow via the pipeline rather than the current river releases.

The extension of the pipeline will require the construction of a new main to the existing reservoir for Kama Furrow. The scheme will also require the same infield remediation as Option A. The required pipeline and refurbishment are as given below and shown in drawing F1 and F2.

The schematic layout of the scheme is shown in Figure 6-5.

Figure 6-5: Schematic layout of Kama Furrow



(a) Commercially based option

- 315 mm diameter MPVC main, 7.6 km long;
- Distribution mains, total of 3.7 km;
- Replacement of necessary portions of infield equipment for 51 ha; and
- Fencing of the area, 6150 m

(b) Smallholder irrigator based option

- 250 mm diameter MPVC main, 7.6 km long;
- Distribution mains, total of 3.7 km;
- Replacement of necessary portions of infield equipment for 51 ha; and
- Fencing of the area, 6150 m.

6.5.3 Scheme cost

(a) Commercially based option

The capital and operational costs for the commercial bases option are presented in Table 6-33 and Table 6-34 respectively, based on 2007 costs.

Table 6-33: Construction costs of commercial option at Kama Furrow

Item	**Amount (R Excl VAT) (Base year 2007)**
Pipelines	5,825,223.51
Fencing	767,375.00
Infield	598,075.00
Construction total	7,190,673.51
Design & supervision fees - 16%	1,150,507.76
Total	**8,341,181.27**

Table 6-34: Annual operations and maintenance costs of commercial option at Kama Furrow

Item	**Amount (R Excl VAT) (Base year 2007)**
Civil	111,708.99
M&E	0.00
Energy – Eskom	0.00
Water charges	15,695.49
Total	**127,404.48**

The ongoing annual operations and maintenance costs for running the scheme at its designed level include normal maintenance costs of the infrastructure and the ongoing water charges.

(b) Smallholder irrigator based option

The capital and operational costs for the smallholder irrigator option are presented in Table 6-35 and Table 6-36 respectively, based on 2007 costs.

Table 6-35: Construction costs of smallholder option at Kama Furrow

Item	**Amount (R Excl VAT) (Base year 2007)**
Pipelines	4,641,028.09
Fencing	767,375.00
Infield	598,075.00
Construction total	6,006,478.09
Design & supervision fees - 16%	961,036.50
Total	**6,967,514.59**

Table 6-36: Annual operations and maintenance costs of smallholder irrigator option at Kama Furrow

Item	**Amount (R Excl VAT) (Base year 2007)**
Civil	104,509.64
M&E	0.00
Energy – Eskom	0.00
Water charges	14,804.34
Total	**119,313.98**

The ongoing annual operations and maintenance costs for running the scheme at its designed level include normal maintenance costs of the infrastructure and the ongoing water charges.

(c) Commercial underutilised option

The capital for the commercial design option is the same as illustrated in Table 6-33. The operational costs of the smallholder irrigator on the commercial designed system are shown in Table 6-37, based on 2007 costs.

Table 6-37: Operations and maintenance costs of commercial underutilised option at Kama Furrow

Item	**Amount (R excl VAT) (Base year 2007)**
Civil	111,377.97
M&E	0.00
Energy – Eskom	0.00
Water charges	14,804.34
Total	**126,182.31**

6.6 Mantusini scheme

6.6.1 Water requirements for crops

Water requirements for the crop patterns were calculated using the SAPWAT software released by the Water Research Commission (Crosby, 1999) as presented in Table 6-38 for commercially based water demands, and Table 6-39 for reduced water demand.

Table 6-38: Gross crop water requirements for commercially based demands at Mantusini

Month	Typical fresh vegetables - summer crop			Dry maize - summer crop			Typical fresh vegetables - winter crop			Total
	mm/ha	ha	m^3/annum	mm/ha	ha	m^3/annum	mm/ha	ha	m^3/annum	m^3/annum
Jan	139.1	24	33,384	67.6	6	4,056				37,440
Feb										
March										
April							58.5	9.9	5,792	5,792
May							91	9.9	9,009	9,009
June							76.7	9.9	7,593	7,593
July							14.3	9.9	1,416	1,416
Aug										
Sep				18.2	6	1,092				1,092
Oct	14.3	24	3,432	58.5	6	3,510				6,942
Nov	57.2	24	13,728	88.4	6	5,304				19,032
Dec	141.7	24	34,008	153.4	6	9,204				43,212
Total	**352.3**		**84,552**	**386.1**		**23,166**	**240.5**		**23,810**	**131,528**

Table 6-39: Gross crop water requirements for reduced demands at Mantusini

Month	Typical fresh vegetables - summer crop			Dry maize - summer crop			Typical fresh vegetables - winter crop			Total
	mm/ha	ha	m^3/annum	mm/ha	ha	m^3/annum	mm/ha	ha	m^3/annum	m^3/annum
Jan	97.37	24	23,369	47.32	6	2,839				26,208
Feb										
March										
April							40.95	9.9	4,054	4,054
May							63.7	9.9	6,306	6,306
June							53.69	9.9	5,315	5,315
July							10.01	9.9	991	991
Aug										
Sep				12.74	6	764				764
Oct	10.01	24	2,402	40.95	6	2,457				4,859
Nov	40.04	24	9,610	61.88	6	3,713				13,322
Dec	99.19	24	23,806	107.38	6	6,443				30,248
Total	**246.61**		**59,186**	**270.27**		**16,216**	**168.35**		**16,667**	**92,069**

6.6.2 Proposed infrastructure for primary option

The hydrological evaluation has shown that there is limited water available in the river due to the current irrigation activity on the Mngazi River and the need for a substantial environmental reserve. A scheme, in the order of 30 ha, is immediately possible with future expansion up to approximately 150 ha in total on the Mngazi River from Mantusini to the river mouth.

This is stated with the knowledge that available soils will be limited and that expansion will be based on the outcome of a DWA review of the environmental reserve established for the Mngazi River.

Given the above uncertainties, the proposed irrigation infrastructure is designed on the principle of a modular 10 ha system, which allows for growth of the system after the initial development, when it is successful and when further expansion is needed. The system will include portable electric pump stations on wheeled wagons (housed in lockable pump houses) that will pump directly to the lands. Three such modular systems, totalling 30 ha, are envisaged in the final stage of the proposed Mantusini development.

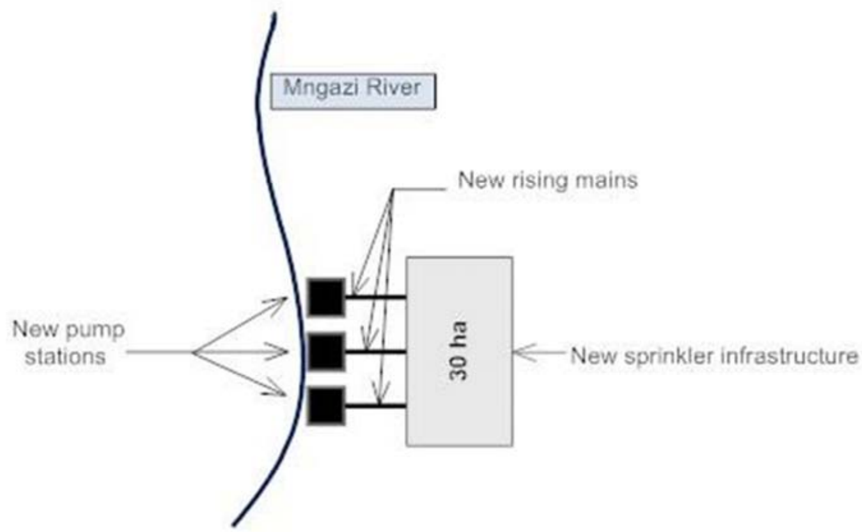
The Mantusini soils are generally very heavy with impeded drainage and a small portion of medium potential soils, the best in the locality, has been selected as most appropriate. The proposed 30 ha scheme will utilise a section of the available land near Mantusini village on the north bank of the Mngazi River, just down-slope of the old TRACOR storage sheds and depot. TRACOR is a former parastatal organisation responsible for irrigation operations in the Eastern Cape. An Eskom supply is available in the area and this will need to be extended to the proposed pump station positions.

The farmers will draw water from the Mngazi River. Agreement will need to be reached within the co-operative on who will benefit from the intervention as the land with suitable soils is currently assigned to specific individuals for rain-fed production.

The proposed infrastructure for the scheme will incorporate pumping directly to the irrigated lands. An Eskom supply has been installed in the area, and allows for the use of electric pumps. The water from the river will be pumped via a rising main directly to the infield infrastructure. The proposed infrastructure is summarised below and shown in drawing G1 and G2:

The schematic layout of the scheme is shown in Figure 6-6.

Figure 6-6: Schematic layout of Mantusini



(a) Commercially based option

- Construction of 6 km of Eskom electrical lines;
- 3 x Portable pump stations with concrete ramp (18.34 l/s);
- 3 x Rising mains (160 mm diameter MPVC, 300 m in length); and
- Infield infrastructure for 30 ha.

(b) Smallholder irrigator based option

- Construction of 6 km of Eskom electrical lines;
- 3 x Portable pump stations with concrete ramp (13.6 l/s);
- 3 x Rising mains (110mm diameter MPVC, 300 m in length); and
- Infield infrastructure for 30 ha.

6.6.3 Scheme cost

(a) Commercially based option

The capital and operational costs for the commercial bases option are presented in Table 6-40 and Table 6-41 respectively, based on 2007 costs.

Table 6-40: Construction costs of commercial option at Mantusini

Item	**Amount (R excl VAT) (Base year 2007)**
Pump station	851,625.00
Pipelines	252,141.23
Infield	967,500.00
Construction total	2,071,266.23
Design & supervision fees - 16%	331,402.60
Total	**2,402,668.83**

Table 6-41: Operations and maintenance costs of commercial option at Mantusini

Item	Amount (R excl VAT) (Base year 2007)
Civil	7,073.92
M&E	12,465.00
Energy – Eskom	63,902.65
Water charges	881.23
Total	**84,322.80**

The ongoing annual operations and maintenance costs for running the scheme at its designed level include normal maintenance costs of the infrastructure and the ongoing water charges.

(b) Smallholder irrigator based option

The capital and operational costs for the smallholder irrigator option are presented in Table 6-42 and Table 6-43 respectively, based on 2007 costs.

Table 6-42: Construction costs of smallholder option at Mantusini

Item	Amount (R excl VAT) (Base year 2007)
Pump station	877,500.00
Pipelines	138,678.14
Infield	855,000.00
Construction total	1,871,178.14
Design & supervision fees - 16%	299,388.50
Total	**2,170,566.64**

Table 6-43: Operations and maintenance costs of smallholder option at Mantusini

Item	Amount (R excl VAT) (Base year 2007)
Civil	5,763.33
M&E	12,600.00
Energy – Eskom	47,294.67
Water charges	616.86
Total	**66,274.87**

The ongoing annual operations and maintenance costs for running the scheme at its designed level include normal maintenance costs of the infrastructure and the ongoing water charges.

(c) Commercial underutilised option

The capital for the commercial design option is the same as illustrated in Table 6-40. The operational costs of the smallholder irrigator on the commercial designed system are shown in Table 6-44, based on 2007 costs.

Table 6-44: Operations and maintenance costs of commercial underutilised option at Mantusini

Item	**Amount (R excl VAT) (Base year 2007)**
Civil	7,073.92
M&E	12,465.00
Energy – Eskom	52,389.65
Water charges	616.86
Total	**72,545.43**

7 RESULTS

7.1 Comparison of irrigator level of supply

Summarising the costs of the interventions of each of the schemes allows comparison between the schemes and the style of system suggested.

A summary of the capital, operations and maintenance costs for the commercial and smallholder irrigator level of supply are given in Table 7-1 to Table 7-5.

The cost reflected in the tables includes the following:

- Capital Cost: This represented the actual amount required to implement the infrastructure for the scheme, expressed as a cost per hectare. This provides for an easy comparison between the schemes.
- O&M: The operations and maintenance costs cover the O&M costs pertaining to the infrastructure. The operational costs include water charges, water user association charges and electrical operational costs. There is no allocation for labour in the O&M costs.
- The volume of water is the annual volume of water anticipated to be used on the scheme.
- Annual cost of water: This covers the annual O&M costs per m^3 of water used on the scheme. The cost does not allow for capital repayment. The cost of operating the scheme can be calculated on a consumptive basis and is measured in R per m^3. The lower the cost per m^3, the greater the value to the users as it will cost them less to utilise the same amount of water.

7.1.1 Commercial level of supply

The development and O&M costs for each of the schemes, designed according to the commercial level of supply are presented in Table 7-1.

Table 7-1: Summary of costs for commercial level of supply

Scheme	Area (ha)	Capital cost		O&M (R/ha)	Volume of water required (m^3)	Annual cost of water (R/m^3)
		R x10^6	R / ha			
Kama Furrow, Extension of Pipeline	50.90	8.34	163,874	2,503	443,357	0.29
Wolf River, Section in Zanyokwe	25.00	1.08	44,027	2,527	213,188	0.30
Ncambedlana	85.00	10.78	217,855	11,734	622,237	1.60
Tamboekiesvlei	33.84	5.28	155,888	635	273,901	0.08
Mantusini	30.00	2.40	80,077	2,811	131,528	0.64
Kruisfontein	19.21	0.64	33,396	213	132,239	0.03

Table 7-2 shows the summary of capital costs for the commercial level of supply. The results provide for varying ranges of costs across the schemes. The capital cost per hectare of the schemes shows three distinct groups.

Table 7-2: Scheme grouping for capital costs for commercial level of supply

Group	Scheme	Scheme type	Capital costs (R x10^3 / ha)
1	Wolf River Kruisfontein	Rehabilitation gravity Rehabilitation pumped	33 - 44
2	Mantusini Ncambedlana	Run-of-river – pumped to infield Run-of-river – pumped to storage	80 - 127
3	Tamboekiesvlei, Kama Furrow	Gravity with bulk supply	156 - 164

At the low cost end of the capital costs are the Wolf River and Kruisfontein schemes. The two schemes are predominately rehabilitation and water conservation with little or no infield costs. Mantusini and Ncambedlana fall between the low cost schemes and the higher cost schemes. Their costs differ, but what is interesting is that they are both pumped schemes with little or no storage. The remaining schemes cost approximately R160,000 per ha and are all gravity based schemes. Table 7-2 shows that the initial capital costs are likely to be linked to the type of scheme. A scheme which will be rehabilitated may cost less. A new pumped scheme would cost more than the rehabilitated scheme, with the third group, new gravity schemes, the most expensive.

Table 7-3: Scheme grouping for O&M costs for commercial level of supply

Group	Scheme	Scheme type	O&M (R / ha)
1	Kruisfontein, Tamboekiesvlei	Rehabilitation gravity Gravity with bulk supply	210 – 630
2	Mantusini Wolf River Kama Furrow	Run-of-river – pumped Rehabilitation pumped Gravity with bulk supply	2,500 – 2,810
3	Ncambedlana	Run-of-river – pumped to storage	11,730

The O&M costs also have three distinct groupings as shown in Table 7-3. The lowest are the gravity schemes of Kruisfontein and Tamboekiesvlei. The next range, at approximately R2,600 / ha, consists of two pumped schemes and Kama Furrow, which requires large bulk infrastructure. The last range and the highest costs are for Ncambedlana which is a pumped scheme with high pressure and large flow rates. The table reflects that gravity schemes are likely to have lower O&M costs than a pumped scheme. A gravity scheme with significant infrastructure would however have higher O&M costs similar to a smaller pumped scheme. A pumped scheme to storage is shown to have higher O&M costs than any of the other schemes.

Table 7-4: Scheme grouping for annual water costs for commercial level of supply

Group	Scheme	Scheme type	Annual cost of water (R / m^3)
1	Kruisfontein, Tamboekiesvlei	Rehabilitation gravity Gravity with bulk supply	0.03 – 0.08
2	Wolf River Kama Furrow	Rehabilitation pumped Gravity with bulk supply	0.29 - 0.30
3	Mantusini	Run-of-river – pumped	0.64
4	Ncambedlana	Run-of-river – pumped to storage	1.60

The annual cost of the water per m^3 follows a similar pattern as that of the O&M costs as shown in Table 7-4. The gravity schemes provide the lowest annual costs with the pumped schemes forming the upper range. The larger infrastructure brings the gravity Kama Furrow on par with the rehabilitated Wolf River. The table hence shows that a gravity scheme will likely have a lower annual cost than a pumped scheme. A larger gravity scheme will be more equivalent to a rehabilitated pumped scheme and new pumped schemes will have the highest annual cost of water.

7.1.2 Smallholder level of supply

The Smallholder LOS cost analysis summary is shown in Table 7-5.

Table 7-5: Summary of costs for smallholder irrigator level of supply

Scheme	Area (ha)	Capital cost		O&M (R/ha)	Volume of water required (m^3)	Annual cost of water (R/m^3)
		R x10^6	R / ha			
Kama Furrow, Extension of Pipeline	50.90	6.97	136,886	2,344	310,350	0.38
Wolf River, Section in Zanyokwe	25.00	1.06	42,433	2,156	149,231	0.36
Ncambedlana	85.00	9.24	181,827	7,553	435,566	1.47
Tamboekiesvlei	33.84	3.50	103,488	442	191,731	0.08
Mantusini	30.00	2.17	72,352	2,209	92,069	0.72
Kruisfontein	19.21	0.45	23,485	150	92,567	0.03

A similar trend is found with the smallholder irrigator LOS (Table 7-6) and the commercial LOS (Table 7-2) regarding the capital cost per hectare. The lower end of the costs consists of rehabilitated schemes, and pumped-to-infield schemes. This shows that the initial capital outlay is lower than that of bulk gravity schemes and pumped to storage schemes.

Table 7-6: Scheme grouping for capital costs for smallholder irrigator level of supply

Group	Scheme	Scheme type	Capital costs (R x10^3 / ha)
1	Wolf River Kruisfontein	Rehabilitation pumped Rehabilitation gravity	23 – 42
2	Mantusini	Run-of-river – pumped	72
3	Tamboekiesvlei Ncambedlana	Gravity with bulk supply Run-of-river – pumped to storage	103 – 109
4	Kama Furrow	Gravity with bulk supply	137

The same trend for O&M costs is evident for the smallholder LOS (Table 7-7). The gravity schemes proved to be the lowest, then the bulk gravity and pumped to infield schemes and, lastly, the high pressure and flow schemes. This indicates that the electricity cost is a large component of the O&M costs.

Table 7-7: Scheme grouping for O&M costs for smallholder irrigator level of supply

Grouping	Scheme	Scheme type	O&M (R / ha)
1	Kruisfontein Tamboekiesvlei	Rehabilitation gravity Gravity with bulk supply	150 - 440
2	Mantusini Wolf River Kama Furrow	Run-of-river – pumped Rehabilitation pumped Gravity with bulk supply	2,160 - 2,340
3	Ncambedlana	Run-of-river – pumped to storage	7,550

The water costs per m^3 are very similar between the commercial and smallholder LOS as indicated in Table 7-4 and Table 7-8. This illustrates that the scheme type is the predominant factor in the annual water costs with gravity schemes being the lowest and pumped schemes on the higher end of the scale. The table hence shows that a gravity scheme will likely have a lower annual cost than a pumped scheme. A larger gravity scheme will be more equivalent to a rehabilitated pumped scheme and new pumped schemes will have the highest annual cost of water.

Table 7-8: Scheme grouping for water costs for smallholder irrigator level of supply

Group	Scheme	Scheme type	Annual cost of water (R / m^3)
1	Kruisfontein Tamboekiesvlei	Rehabilitation gravity Gravity with bulk supply	0.03 – 0.08
2	Wolf River Kama Furrow	Rehabilitation pumped Gravity with bulk supply	0.36 – 0.38
3	Mantusini	Run-of-river – pumped	0.72
4	Ncambedlana	Run-of-river – pumped to storage	1.47

The difference in the costs between schemes for each LOS has been discussed in this section. The difference between the two LOS is however important to determine the impact of the design on capital, O&M and water costs. To illustrate the difference between the costs, the percentage difference between the commercial LOS and the smallholder irrigator LOS, is shown in Table 7-9. The percentage differences have been calculated using Table 7-1 and Table 7-5.

The table presents percentages for each of the criteria. These percentages show the comparison between the commercial LOS and smallholder LOS. Zero percent indicates that there is no difference, a positive percentage that the commercial LOS has a higher value and a negative percentage that the commercial LOS has a lower value than the smallholder LOS option.

Table 7-9: Percentage difference between the commercial and smallholder LOS

Scheme	Area	Capital cost	O&M	Volume of water	Annual cost of water
Gravity: Kama Furrow, Extension of Pipeline	0%	16%	6%	30%	-34%
Pumped: Wolf River, Section in Zanyokwe	0%	4%	15%	30%	-22%
Pumped: Ncambedlana	0%	14%	36%	30%	8%
Gravity: Tamboekiesvlei	0%	34%	30%	30%	1%
Pumped: Mantusini	0%	10%	21%	30%	-12%
Gravity: Kruisfontein	0%	30%	30%	30%	0%

The capital cost has a range of comparative ratios between 4 % and 34 %, with the average about 18 %. There is a 30 % water use variation. However, the capital costs do not increase by the same proportion. This illustrates that the variation of cost is not directly proportional to water use variations. For most of the schemes, the largest variation has been the water utilised.

Figure 7-1: Capital cost of scheme vs. irrigation area

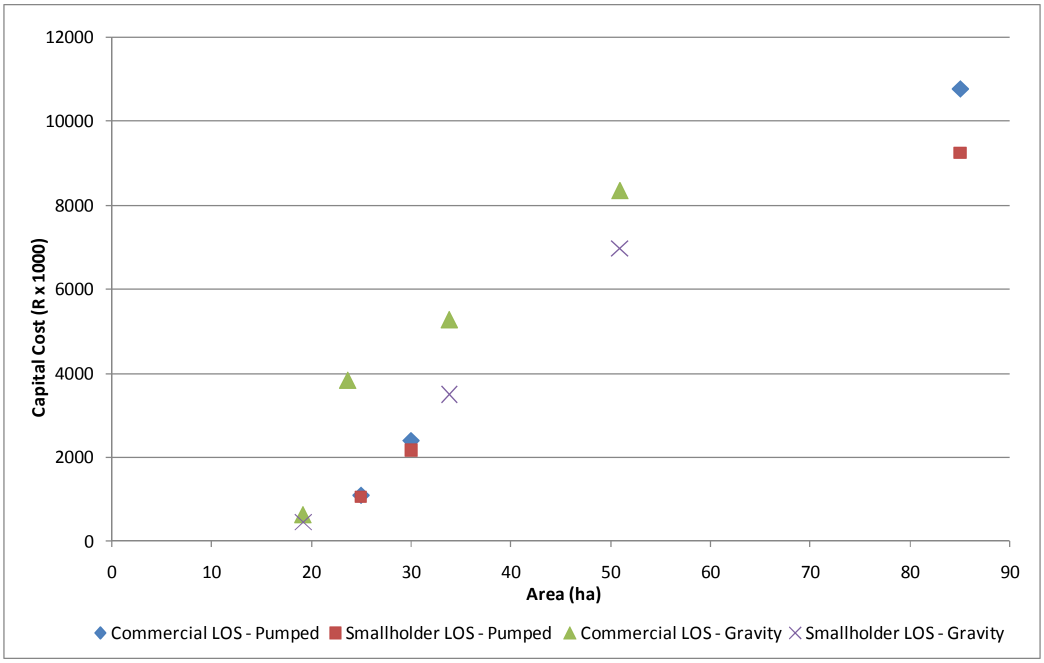
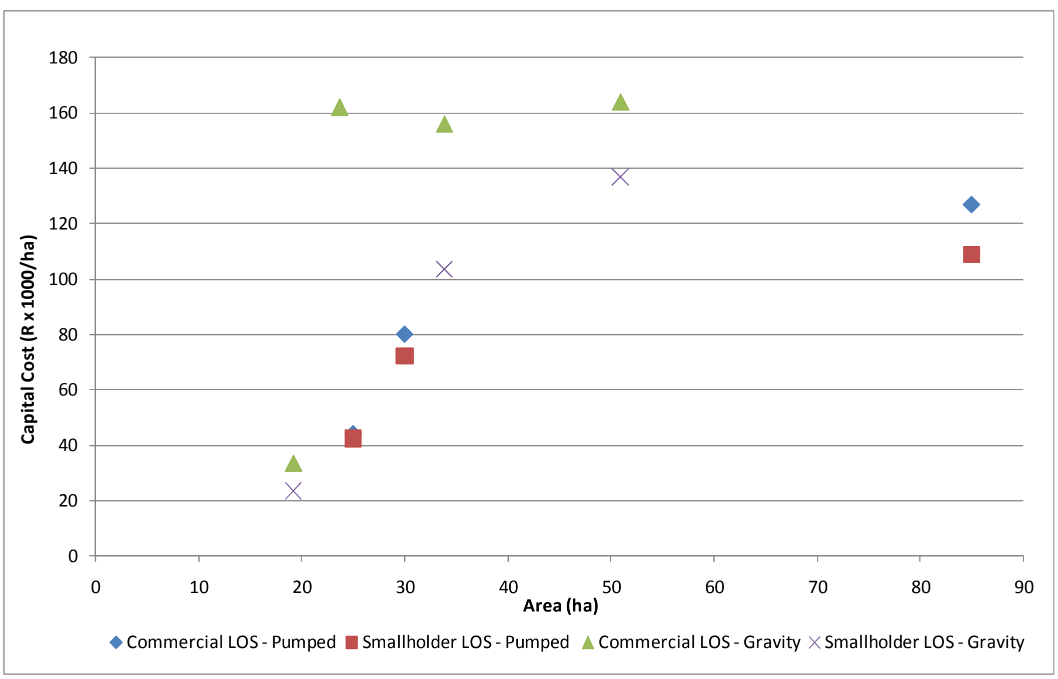


Figure 7-1 illustrates the variation between the two LOS and the general trend that as scheme area increases, so too do the costs.

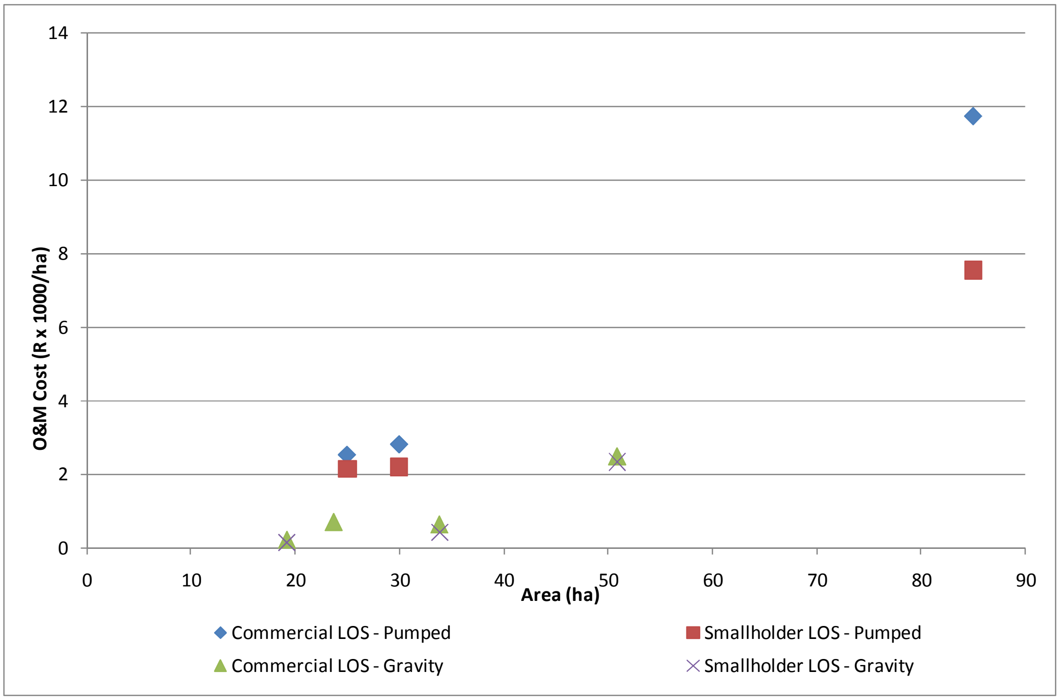
Figure 7-2 indicates the general trend of similar per hectare capital costs for the two different operational approaches. There is a slight increase in development cost as the scheme size increases. This is higher than anticipated for, in general, the economies of scale would benefit the larger schemes.

Figure 7-2: Capital cost of scheme per hectare vs. irrigation area



The O&M costs for the commercial LOS are higher than the smallholder LOS and reflect an increase of between 6 % to 34 %. These costs will have an impact on the farmer on an annual basis and will directly affect the financial viability. This does assume, however, that the capital cost will not be paid back.

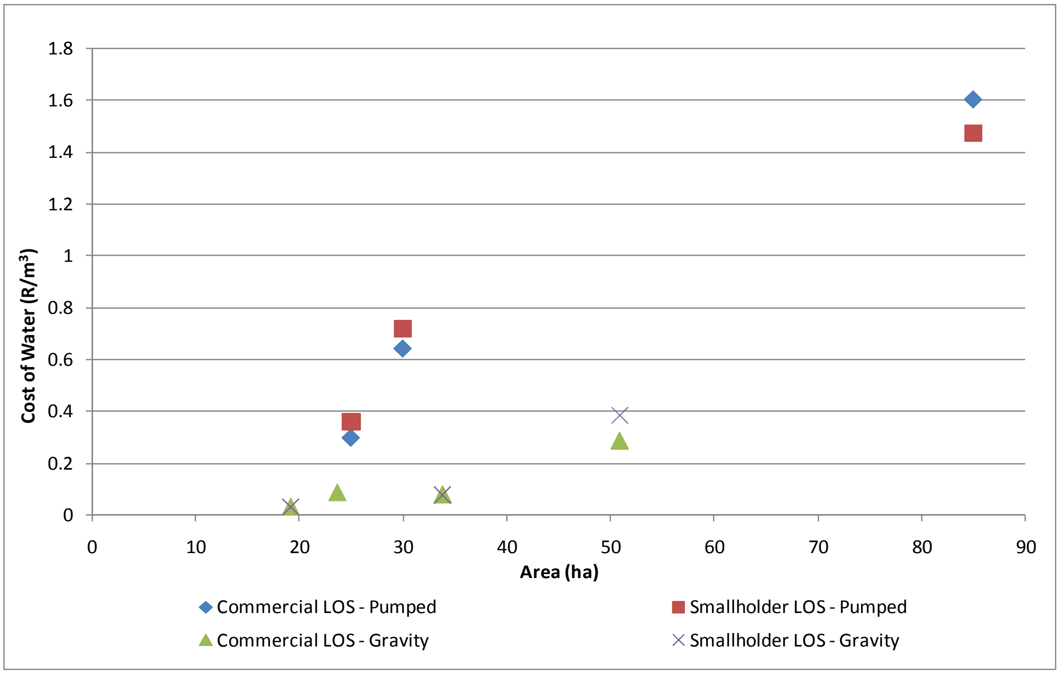
Figure 7-3: O&M cost of scheme vs. irrigation area



The O&M costs for the different types of scheme are shown in Figure 7-3, with a distinct variation between the gravity and pumped schemes. This indicates that the pumped system has higher O&M costs, which are largely attributed to the electricity charges.

There is a correlation between the two LOS and the annual cost of water as shown in Figure 7-4. The correlation shown between the two LOS in Figure 7-4 indicates that, as the scheme area increases, so will the annual water costs.

Figure 7-4: Annual O&M cost of water vs. scheme area



7.1.3 Commercial under utilised level of supply

The two summary tables (Table 7-1 and Table 7-5) are useful for comparison between the commercial and smallholder LOS, and how they affect the initial capital and ongoing operational costs. This does not answer the question of what impact the over-design of the scheme has on the smallholder irrigator. To do this, the scenario of the commercial under-utilised LOS needs to be considered.

The commercial designed scheme has been taken and the water use of the smallholder LOS implemented to represent this scenario. The summary of the costs is shown in Table 7-10.

Table 7-10: Summary of costs for commercial under-utilised LOS

Scheme	Area (ha)	Capital cost		O&M (R/ha)	Volume of water required (m^3)	Annual cost of water (R/m^3)
		R x10^6	R / ha			
Kama Furrow, Extension of Pipeline	50.90	8.34	163,874	2,479	310,350	0.41
Wolf River, Section in Zanyokwe	25.00	1.08	43,303	2,425	149,231	0.41
Ncambedlana	85.00	10.78	217,855	10,409	435,566	2.03
Tamboekiesvlei	33.84	5.28	155,888	618	191,731	0.11
Mantusini	30.00	2.40	80,088	2,418	92,069	0.79
Kruisfontein	19.21	0.64	33,396	199	92,567	0.04

The O&M costs also have three distinct groupings as shown in Table 7-11. The lowest are the gravity schemes of Kruisfontein and Tamboekiesvlei. The next group consists of two pumped schemes and Kama Furrow which has a greater bulk infrastructure. The last range and the highest costs are for Ncambedlana which is a pumped scheme with high pressure and large flow rates. The table reflects that gravity schemes are likely to have lower O&M costs than a pumped scheme. A gravity scheme with significant infrastructure would however have higher O&M costs similar to a smaller pumped scheme. A pumped scheme to storage is shown to have higher O&M costs than any of the schemes.

Table 7-11: Scheme grouping for O&M costs for commercial under-utilised LOS

Group	Scheme	Scheme type	O&M (R / ha)
1	Kruisfontein Tamboekiesvlei	Rehabilitation gravity Gravity with bulk supply	200 - 620
2	Mantusini Wolf River Kama Furrow	Run-of-river – pumped Rehabilitation pumped Gravity with bulk supply	2,420 - 2,480
3	Ncambedlana	Run-of-river – pumped to storage	10,420

The annual cost of water is however higher than both the commercial and smallholder LOS. As expected, the commercial under-utilised LOS is not as cost effective as the other two LOS (as shown in Table 7-12). The table further shows that a gravity scheme is likely to have a lower annual cost than a pumped scheme. A larger gravity scheme will be more equivalent to a rehabilitated pumped scheme and new pumped schemes will have the highest annual cost of water.

Table 7-12: Scheme grouping for water costs for commercial under-utilised LOS

Group	Scheme	Scheme type	Annual cost of water (R / m^3)
1	Kruisfontein, Tamboekiesvlei	Rehabilitation gravity Gravity with bulk supply	0.04 – 0.11
2	Wolf River Kama Furrow	Rehabilitation pumped Gravity with bulk supply	0.41
3	Mantusini	Run-of-river – pumped	0.79
4	Ncambedlana	Run-of-river – pumped to storage	2.03

As before, the commercial under-utilised LOS and smallholder LOS were compared on a percentage basis. The commercial under-utilised LOS (Table 7-10) and the smallholder LOS (Table 7-5) have been compared on a percentage basis in Table 7-3.

Table 7-13: Percentage difference between the commercial under-utilised LOS and smallholder LOS

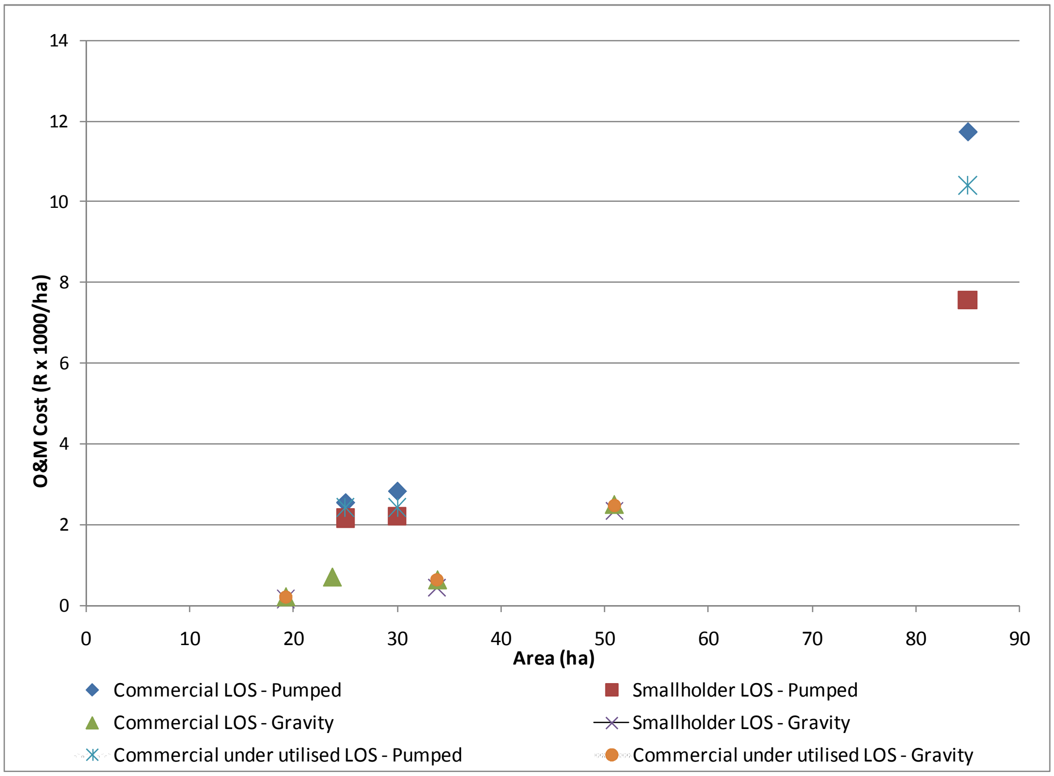
Scheme	Area	Capital cost	O&M	Volume of water	Annual cost of water
Kama Furrow, Extension of pipeline	0%	16%	5%	0%	5%
Wolf River, section in Zanyokwe	0%	2%	11%	0%	11%
Ncambedlana	0%	14%	27%	0%	27%
Tamboekiesvlei	0%	34%	29%	0%	29%
Mantusini	0%	10%	9%	0%	9%
Kruisfontein	0%	30%	25%	0%	25%

Table 7-13indicates that in all aspects the commercial under-utilised LOS is more expensive than a correctly sized scheme. It could be expected that the initial capital costs will be higher for the larger capacity system. If the capital costs do not need to be repaid, it may not have the initial negative impact that it would have to accommodate if the farmers needed to fund the construction themselves. The capital cost has a range of comparative ratios between 2 % and 34 %, with the average about 18 %. The impact of the larger capacity system does however affect the farmer on an ongoing basis in the O&M costs. This is shown with the 5 % to 29 % higher O&M costs. These higher costs will be paid each year by the farmers, thus affecting their financial viability.

A commercial farmer would be producing a higher yield crop and would recoup the additional costs, but this would not be the case for a smallholder irrigator on the same system.

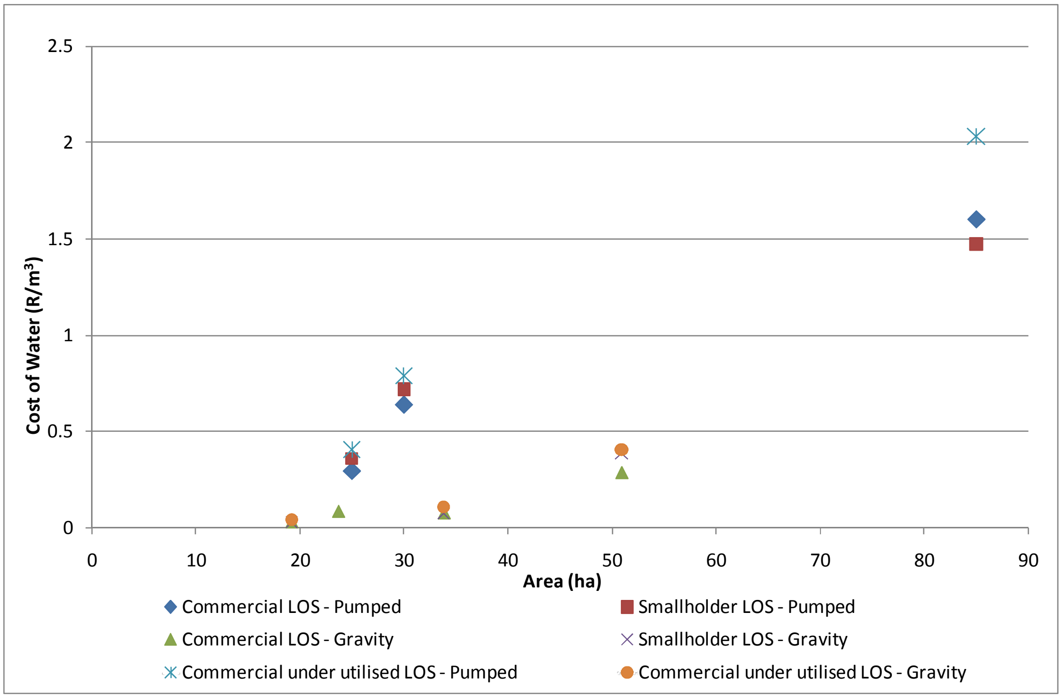
Figure 7-5 shows the O&M costs of the three options. It is evident from the pumped systems that the commercial under-utilised LOS falls between the two other LOS, but closer to the commercial LOS.

Figure 7-5: O&M cost of scheme vs. irrigation area for all three LOS



The higher annual cost of using the water for the commercial under-utilised LOS is shown in Figure 7-6. Where the commercial LOS and smallholder LOS are roughly the same, it can be seen, from Table 7-13, that the commercial under-utilised LOS is significantly higher in the annual water cost, between 5 % – 29 %, than the commercial and smallholder LOS.

Figure 7-6: Annual cost of water vs. irrigation area



7.2 Financial evaluation

The gross margin analysis was based on one hectare under irrigation, planted to a mixture of field crops and vegetables. The hectare would be fully planted to six summer crops, but only 30 % of the area would be utilised for cabbages in winter. The gross margin was calculated for each LOS considering the overall yield difference between a commercial and smallholder irrigator.

The estimated yields and returns are purposely conservative but are still only achievable if farmers have a full range of farmer support services around them to ensure that they have all the necessary business linkages.

The methodology of the financial evaluation was discussed in Section 4.9. The detailed calculations for each scheme and LOS are provided in Appendices N to S. The return on investment has been calculated at year 5 when the initial infrastructure capital debt repayments have reduced and normal working capital requirements account for the lending needs. The calculations show the same return on investment from year 5 till year 19. The return on investment was calculated based on the net benefit after financing over the initial capital outlay. The cash surplus is the net benefit after financing over the irrigable area. A summary of financial evaluation is shown in Table 7-14.

Table 7-14: Financial evaluation of each scheme and LOS

Scheme	LOS	NPV (R)	Net return on investment (%)	Annual cash surplus (R / ha)
Kama Furrow	Commercial	-4,391,249	4.06%	17,762
	Smallholder	-4,794,580	2.41%	8,823
	Commercial under-utilised	-6,306,129	1.94%	8,498
Wolf River	Commercial	3,265,699	35.34%	20,422
	Smallholder	1,685,013	21.69%	12,078
	Commercial under-utilised	1,615,857	20.61%	11,909
Ncambedlana	Commercial	-8,316,079	1.28%	7,260
	Smallholder	-1,125,785	2.72%	4,999
	Commercial under-utilised	-9,340,435	0.39%	2,223
Tamboekiesvlei	Commercial	-243,546	8.03%	22,251
	Smallholder	-250,038	7.21%	13,258
	Commercial under-utilised	-2,169,384	4.69%	12,988
Mantusini	Commercial	2,244,703	16.13%	20,352
	Smallholder	820,951	10.73%	12,224
	Commercial under-utilised	555,314	9.58%	12,079
Kruisfontein	Commercial	4,227,572	68.39%	23,034
	Smallholder	2,604,644	58.27%	13,801
	Commercial under-utilised	2,426,184	40.85%	13,759

The results of the financial evaluation show that a commercially operated farm provides the best NPV and cash surplus. The higher NPV is as expected, since commercial farmers will have higher returns from their crops. The smallholder irrigator has the second best NPV for each of the schemes, except for Ncambedlana which provided the best NPV.

The commercial under-utilised ranks third for each category in Table 7-14. The NPV and net return on investment for the commercial under-utilised LOS is lower than that of the smallholder LOS. The irrigators of the commercial under-utilised LOS will be exposed to higher debt due to the initial costs, with no benefit in ongoing returns. The commercial under-utilised LOS irrigators will be exposed to additional risk compared to the smallholder LOS irrigators by having the additional initial debt.

8 CONCLUSIONS

Six irrigation schemes in the Eastern Cape have been investigated. The selected schemes are shown in Table 8-1 below:

Table 8-1: Selected irrigation schemes

Scheme name	Location	Size (ha)	Water source
Kruisfontein Ext.	Humansdorp	19.21	Seekoei River
Tamboekiesvlei	Kat River	33.84	Tamboekiesvlei Dam
Ncambedlana	Mthatha	85.00	Mthatha River
Wolf River	Keiskammahoek	25.00	Sandile Dam
Mantusini	Port St Johns	30.00	Mngazi Rivers
Kama Furrow	Zanyokwe	50.00	Sandile Dam

From the investigation, development options have been produced and two primary options of farmer types investigated further. These two farmer types are the commercial farmer who uses volumes of water associated with commercial production, and the smallholder irrigator who uses significantly less water for the same irrigation area.

The schemes that were evaluated do not cover all aspects of a possible irrigation development and the results must be interpreted within this context and the items that follow:

- Capital costs only include the construction and related engineering fees;
- Other development items such as training, development and instructional support have not been considered;
- The systems designed were primarily sprinkler and dragline based, with three schemes using sprinklers and draglines, one using drip irrigation, and one using short furrow flood irrigation;
- The system types were limited to gravity and pumped schemes;
- O&M costs only account for the annual costs of operating and maintaining the infrastructure, water charges, Water User Association charges and Eskom electricity usage;
- The water charge was 67 cents per m^3 of water and the Water Users Association for Kama Furrow, Wolf River, and Ncambedlana, R 250 per hectare; and
- No allocation of labour and other expenses was considered in operating the irrigation system.

The infrastructure needed for the commercial LOS accounts for the higher water use which, in turn, results in infrastructure with greater capacity, but with higher construction costs, and higher annual operation and maintenance costs. The infrastructure for the smallholder LOS has been reduced, thus resulting in a reduction of capital and O&M costs.

The evaluation of the two LOS has shown that the capital cost for the commercial LOS is approximately 18 % higher than the smallholder LOS and varied between 4 and 34 %, and the O&M costs are 6 % to 36 % higher. This shows that there is definitely a capital and ongoing O&M cost difference between the commercial and smallholder LOS. The initial capital cost may, in some cases, be grant funded by the government, but the ongoing O&M costs will be for the farmers' account. If the respective farmers are producing the yields associated with the LOS, then there will be no additional burden on them, as the infrastructure has been sized to accommodate the appropriate LOS.

The evaluation provides a general estimate of possible costs associated with each scheme type and LOS. The calculated costs, however, are limited by the individual particulars of the schemes and their location. The costs will therefore not be applicable to every similar scheme. The schemes that were investigated can be grouped into the five general scheme types.

- The first are gravity schemes which need rehabilitation, while the bulk supply is in place with no augmentation or rehabilitation required (Kruisfontein);
- The second includes rehabilitated schemes where water is supplied from a nearby bulk pipeline and pumped directly to the lands (Wolf River);
- The third includes run-of-river schemes where water is abstracted and pumped directly to the lands (Mantusini);
- The fourth includes run-of-river schemes where water is abstracted and pumped to storage (Ncambedlana);and
- The fifth category is that of the gravity schemes where the bulk supplies need to be installed as part of the scheme (Tamboekeisvlei and Kama Furrow).

A summary of the indicative costs of the different categories of schemes is provided in Table 8-2.

Table 8-2: Indicative cost of irrigation schemes

Scheme Type	Commercial LOS			Smallholder LOS		
	Capital cost, (R /ha)	O&M (R/ha)	Annual cost of water (R/m^3)	Capital cost, (R / ha)	O&M (R/ha)	Annual cost of water (R/m^3)
Gravity - rehabilitation	33,397	213	0.03	23,485	150	0.03
Pumped – rehabilitation	44,027	2,527	0.30	42,433	2,156	0.36
Run of river - pumped to field	80,089	2,811	0.64	72,352	2,209	0.72
Run of river - pumped to storage	126,877	11,734	1.60	108,704	7,553	1.47
Gravity with bulk supply	163,874 – 155,888	2,503 – 634	0.29 – 0.08	136,886 – 103,488	2,344 – 441	0.38 – 0.08

One of the objectives of the study is to determine the impact on the smallholder irrigators who find themselves on a commercial LOS system. This can either be on a scheme that has already been designed, or could be a new system. The new system design could be done on a commercial LOS simply because the designer has not taken into account the type of irrigator who they are catering for, or who expects that the smallholder irrigators will attain a commercial LOS in the future. If the smallholder irrigators are to attain a commercial LOS in the future, there will be a benefit in that the system will cater for the higher LOS required. If the irrigators, however, do not have any desire, the necessary skills, maintenance support, sufficient training, access to credit, or links to markets to attain a commercial LOS, then they will continue to operate at a smallholder LOS.

Under the circumstances where the smallholder irrigators are never going to achieve a commercial LOS, they will find themselves using a system that is not optimised to either their skills or their water needs. The impact of this was considered and the commercial under-utilised LOS scenario compared to that of a smallholder LOS.

The evaluation of the commercial under-utilised LOS and the smallholder LOS has shown that the capital cost is 18 % higher and the O&M costs 5 % to 29 % higher when evaluating the commercial under-utilised LOS. The capital cost variation is the same as for the commercial LOS and the smallholder LOS because the system design is exactly the same. The O&M variation is higher than expected with the same water use. The larger variation indicates that the costs of maintaining the higher cost infrastructure and operation of higher capacity pumps does have a significant impact on the smallholder irrigator.

The smallholder irrigators who find themselves on a commercial LOS are therefore at a definite disadvantage compared to those on a smallholder LOS scheme. Even if the initial capital costs are funded by grants from the government, there will be the higher annual operating costs. This will directly affect the margins of the farmers, and how much profit they will make from the venture. It could further affect the sustainability of the farmers on such a system. There will, in all likelihood, be higher failures of the farmers, and a need to consolidate land and manage larger areas in order to generate greater profits to overcome the higher O&M costs.

A further indication of the cost effectiveness of the smallholder LOS is found in the annual costs. The commercial under-utilised LOS is significantly higher in the range of 5 % – 29 % as shown in Figure 7-5. This immediately indicates that a smallholder irrigator using less water on a commercial LOS is not operating at an optimum, and the water use is not as cost effective as the correctly designed schemes.

Figure 7-6 is significant as the commercial LOS and smallholder LOS are both well below the commercial under-utilised LOS values. This shows that the design and water use are at an optimum for both types of designs for the situation.

The financial evaluation gives further evidence that there is little benefit for a smallholder irrigator on a commercial scheme. The smallholder irrigator will achieve lower returns and take on additional risk with high debt. Table 8-3 shows that the commercial under-utilised LOS provides the lowest NPV, net return on investment and annual cash surplus.

Table 8-3: Financial evaluation per each scheme type

Scheme Type	Commercial LOS			Smallholder LOS		
	NPV (R)	**Net return on investment (%)**	**Annual cash surplus (R / ha)**	**NPV (R)**	**Net return on investment (%)**	**Annual cash surplus (R / ha)**
Gravity - rehabilitation	4,227,572	68.39%	23,034	2,604,644	58.27%	13,801
Pumped – rehabilitation	3,265,699	35.34%	20,422	1,685,013	21.69%	12,078
Run of river - pumped to field	2,244,703	17.47%	14,695	2,328,460	11.86%	9,007
Run of river - pumped to storage	-8,316,079	1.28%	7,260	-1,125,785	2.72%	4,999
Gravity with bulk supply	-243,546 – -4,391,249	8.03% – 4.06%	22,251 – 17,762	-250,038 – -4,794,580	7.21% – 2.41%	13,258 – 8,823

9 RECOMMENDATIONS

In deciding how to apply the information generated by the study, the situations and farmer types in which they will be applied must be understood.

It is therefore relevant to consider the types of farmers. The work by Denison and Manona (2006) and Van Averbeke and Mohamed (2005) are useful references in this regard.

One of the most important findings of the Van Averbeke and Mohamed (2005) study was the attitude of the farmers. There was no evidence that the farmers who fell into a specific group aspired to achieve a higher level of production. This is of particular importance when a scheme is being designed under the premise that a set of farmers will initially operate as smallholder irrigators and will, over time, become business farmers. The objectives of the farmers determined the category in which they could be allocated. Only when the objectives of the farmers altered would they move into a different category.

The understanding of the farmer types and their objectives correlates directly with the design of the scheme. When a scheme design is simply imposed on a set of beneficiaries, it will most likely not be designed in a manner that matches the needs of the beneficiaries. This is often due to a lack of interaction with the beneficiaries to determine their objectives and to gain an understanding of their needs. If this "top-down" methodology is followed, it will likely result in a poorly matched scheme design and possible failure.

With the understanding, therefore, that the scheme design needs direct interaction with the farmers, the design can then best be matched to the objectives of the farmers. A consultative approach is therefore needed to understand the objectives of the farmers and the risks that they are willing to take. This will then enable the designer to categorise the farmers into the farmer types and the system can be designed appropriately.

The business farmers will likely require the commercial LOS, as they are willing to take higher risk, will have financing to cover the higher inputs and will have market access to sell the larger amounts of produce.

The smallholder farmer will require the design based on the smallholder LOS as this is most suited to a more risk-averse farming style where inputs are reduced and reliance on outside assistance is not an important component.

Equity labourers are unlikely to be directly involved in the scheme design as they would have leased their land to a commercial enterprise, which would imply a commercial LOS.

Food producers are not well described by either a commercial LOS or a smallholder LOS. This is due to their primary objective being to supply food for the household, and the increased running costs will not enable them to continue to do so. They would require a different intervention than the supply of an irrigation scheme. They would be ideal candidates for homestead gardens with the possibility of leasing their plot to a more suitable farmer.

Understanding the farmer types and the appropriate LOS allows for correlation of the results from the schemes that have been evaluated. The farmer type, anticipated LOS and the associated costs from the evaluation have been incorporated in Table 9-1.

Table 9-1: Anticipated cost of irrigation schemes according to farmer type

Farmer type	LOS	Cost	Scheme Type				
			Gravity - infield rehabilitation	Pumped – rehabilitation	Run of river - pumped to field	Run of river - pumped to storage	Gravity with bulk supply
Commercial (business) farmer	Commercial LOS	Capital cost (R / ha)	33,397	44,027	80,089	126,877	163,874 – 155,888
		O&M (R / ha)	213	2,527	2,811	11,734	2,503 – 634
		Annual cost of water (R / m^3)	0.03	0.30	0.64	1.60	0.29 – 0.08
Smallholder farmer	Smallholder LOS	Capital cost (R x10^3/ha)	23,485	42,433	72,352	108,704	136,886 – 103,488
		O&M (R / ha)	150	2,156	2,209	7,553	2,344 – 441
		Annual cost of water (R / m^3)	0.03	0.36	0.72	1.47	0.38 – 0.08

When approaching a new project where the farmer type and the scheme type have been determined, Table 9-1 can be used to provide a starting point for the anticipated LOS and associated costs.

The design of the scheme can then be directly linked to the affected farmer. The design of any scheme must involve a consultative approach to determine the objectives of the farmers and their ability to manage risk. Once this has been determined, the scheme can be designed for an appropriate LOS.

The values in Table 9-1 assist in the estimation of the initial capital and ongoing O&M costs. The possible financial returns of each type of scheme and LOS are shown in Table 9-2.

Table 9-2: Anticipated returns on irrigation schemes according to farmer type

Farmer type	LOS	Financial item	Scheme Type				
			Gravity - infield rehabilitation	Pumped – rehabilitation	Run of river - pumped to field	Run of river - pumped to storage	Gravity with bulk supply
Commercial (business) farmer	Commercial LOS	Net return on investment (%)	68.39%	35.34%	17.47%	1.28%	8.03 – 4.06
		Annual cash surplus per ha (R / ha)	23,034	20,422	14,695	7,260	22,251 – 17,762
Smallholder farmer	Smallholder LOS	Net return on investment (%)	58.27%	21.69%	11.86%	2.72%	7.62 – 2.41
		Annual cash surplus per ha (R / ha)	13,801	12,078	9,007	4,999	13,258 – 8.823

The study is limited by the type of systems that were applicable to each of the schemes. Additional research should take place to extend the estimates and applicable scheme design to encompass other scheme types. The estimated costs will need to be updated every two years, as escalation of materials, plant and labour costs will bring increases to both capital and O&M costs.

New or revitalised schemes should also be monitored to determine issues of success or failure. These can then be used to revise future designs or LOS that may subsequently be designed.

The manner in which consultation with beneficiaries takes place may need to be revised if their objectives are to be accurately determined. Currently, on many schemes, the level of consultation is somewhat limited with the system designer proposing a system to the beneficiaries. With more detailed consultation, the selection of the LOS for a scheme can be matched to the objectives of the farmers and so will tend to increase the project success ratio.

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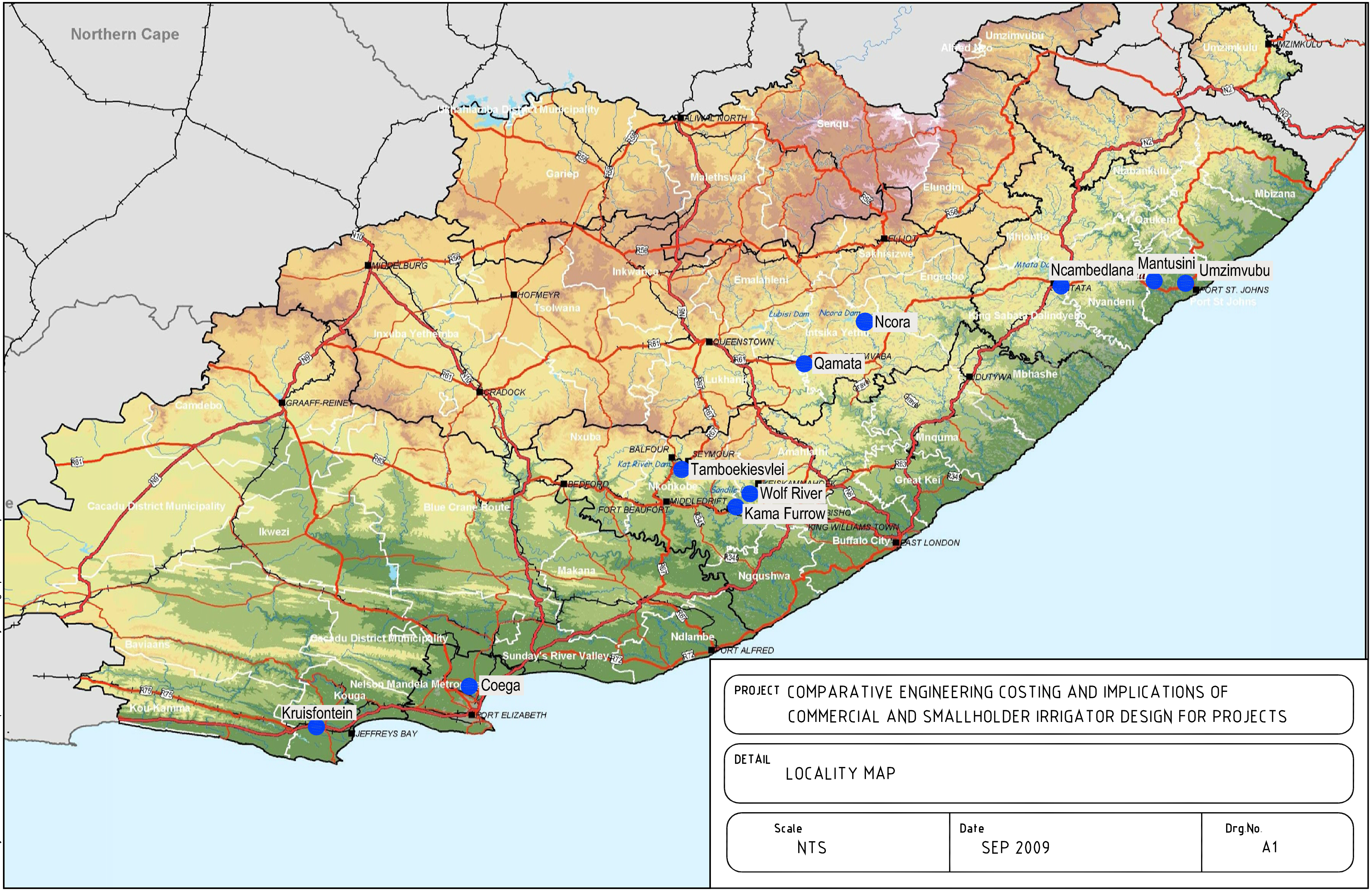
APPENDIX A
Locality Plan



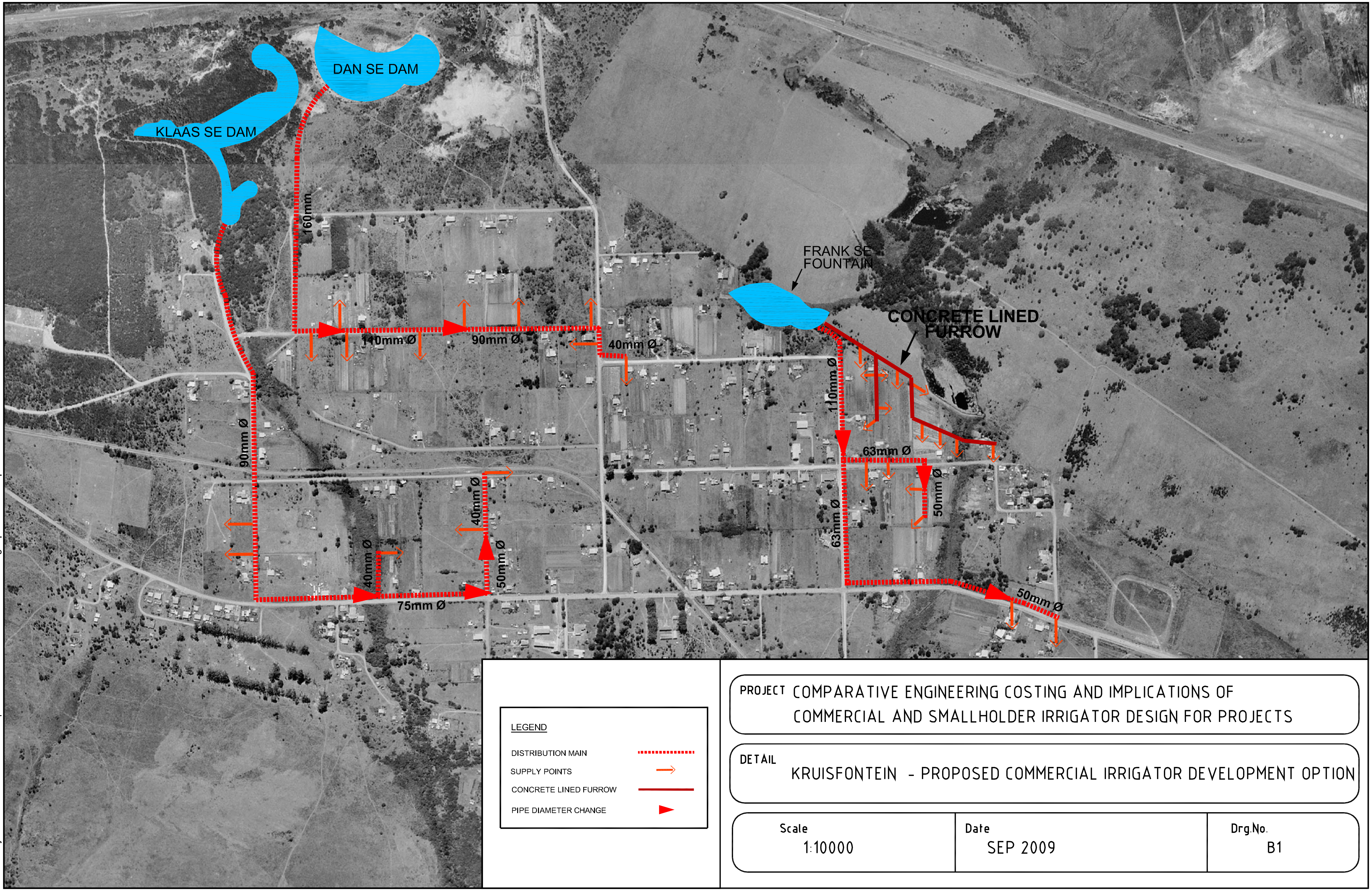
PROJECT COMPARATIVE ENGINEERING COSTING AND IMPLICATIONS OF COMMERCIAL AND SMALLHOLDER IRRIGATOR DESIGN FOR PROJECTS

DETAIL LOCALITY MAP

Scale	Date	Drg.No.
NTS	SEP 2009	A1

APPENDIX B

Scheme Layouts: Kruisfontein



PROJECT	COMPARATIVE ENGINEERING COSTING AND IMPLICATIONS OF COMMERCIAL AND SMALLHOLDER IRRIGATOR DESIGN FOR PROJECTS
DETAIL	KRUISFONTEIN - PROPOSED COMMERCIAL IRRIGATOR DEVELOPMENT OPTION

Scale	Date	Drg.No.
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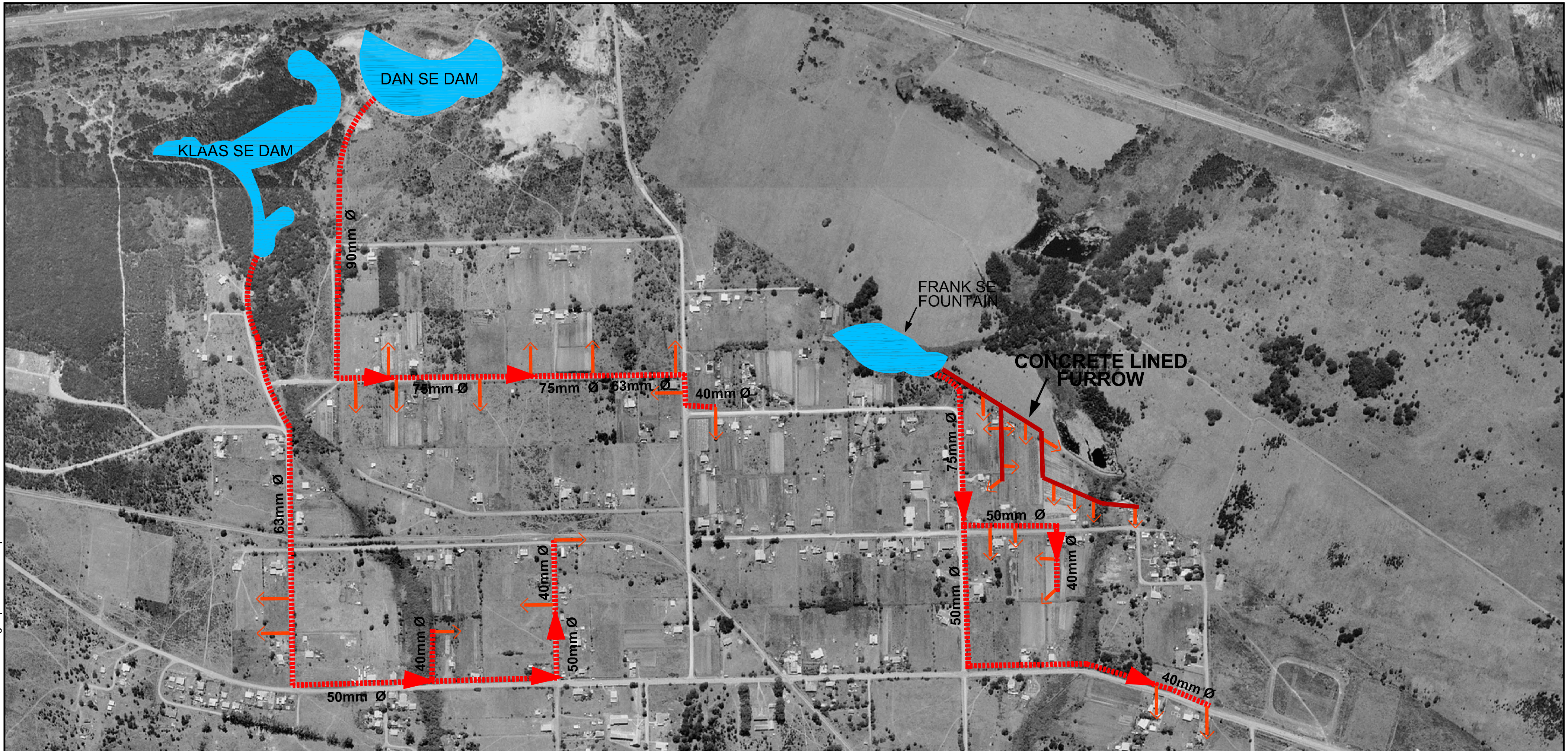

LEGEND

DISTRIBUTION MAIN	
SUPPLY POINTS	
CONCRETE LINED FURROW	
PIPE DIAMETER CHANGE	

PROJECT COMPARATIVE ENGINEERING COSTING AND IMPLICATIONS OF COMMERCIAL AND SMALLHOLDER IRRIGATOR DESIGN FOR PROJECTS

DETAIL KRUISFONTEIN - PROPOSED SMALLHOLDER IRRIGATOR DEVELOPMENT OPTION

Scale	Date	Drg.No.
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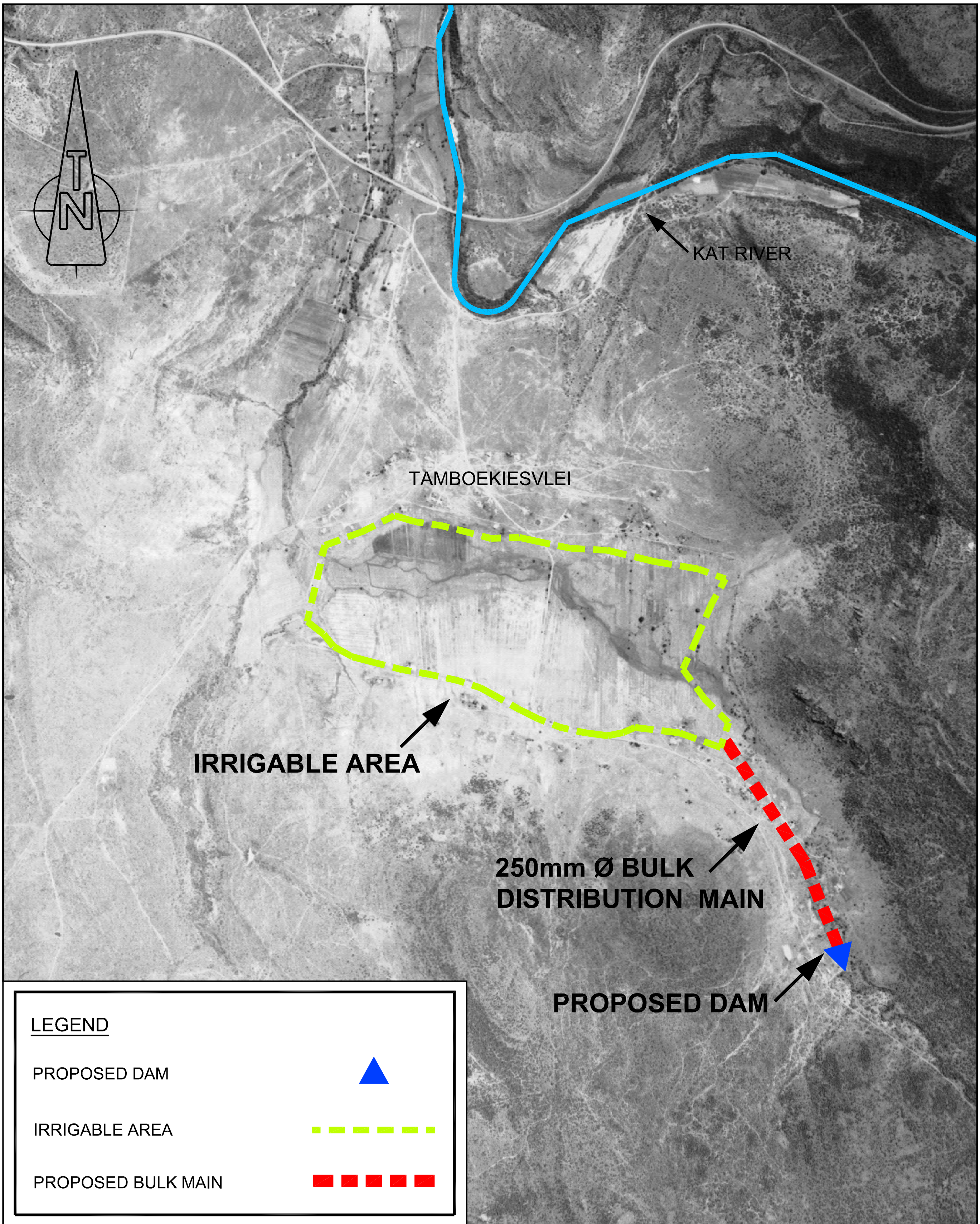
APPENDIX C

Scheme Layouts: Tamboekisevlei



PROJECT COMPARATIVE ENGINEERING COSTING AND IMPLICATIONS OF COMMERCIAL AND SMALLHOLDER IRRIGATOR DESIGN FOR PROJECTS

DETAIL TAMBOEKIESVLEI - PROPOSED COMMERCIAL IRRIGATOR DEVELOPMENT OPTION

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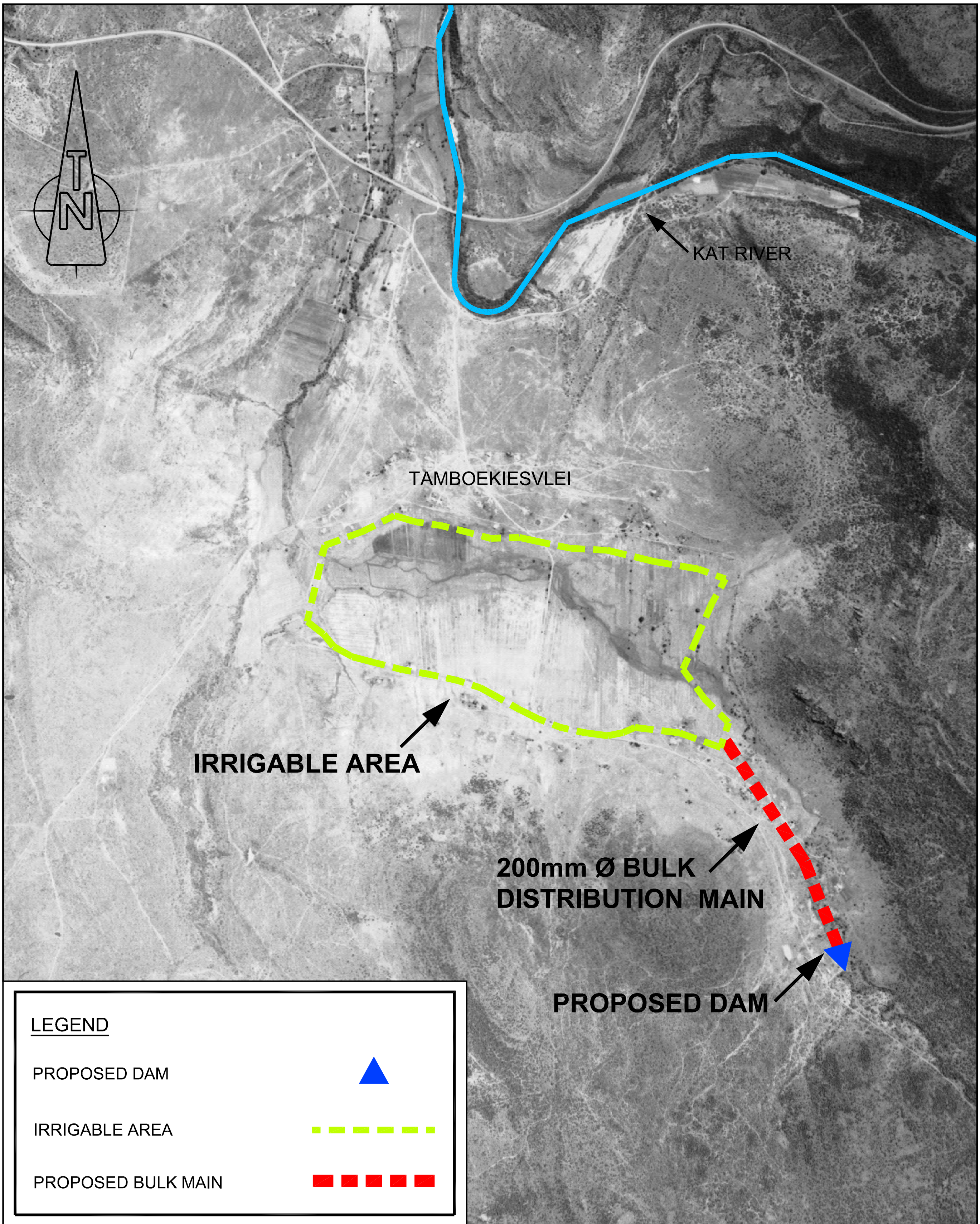

PROJECT COMPARATIVE ENGINEERING COSTING AND IMPLICATIONS OF COMMERCIAL AND SMALLHOLDER IRRIGATOR DESIGN FOR PROJECTS

DETAIL TAMBOEKIESVLEI - PROPOSED SMALLHOLDER IRRIGATOR DEVELOPMENT OPTION

Scale	Date	Drg.No.
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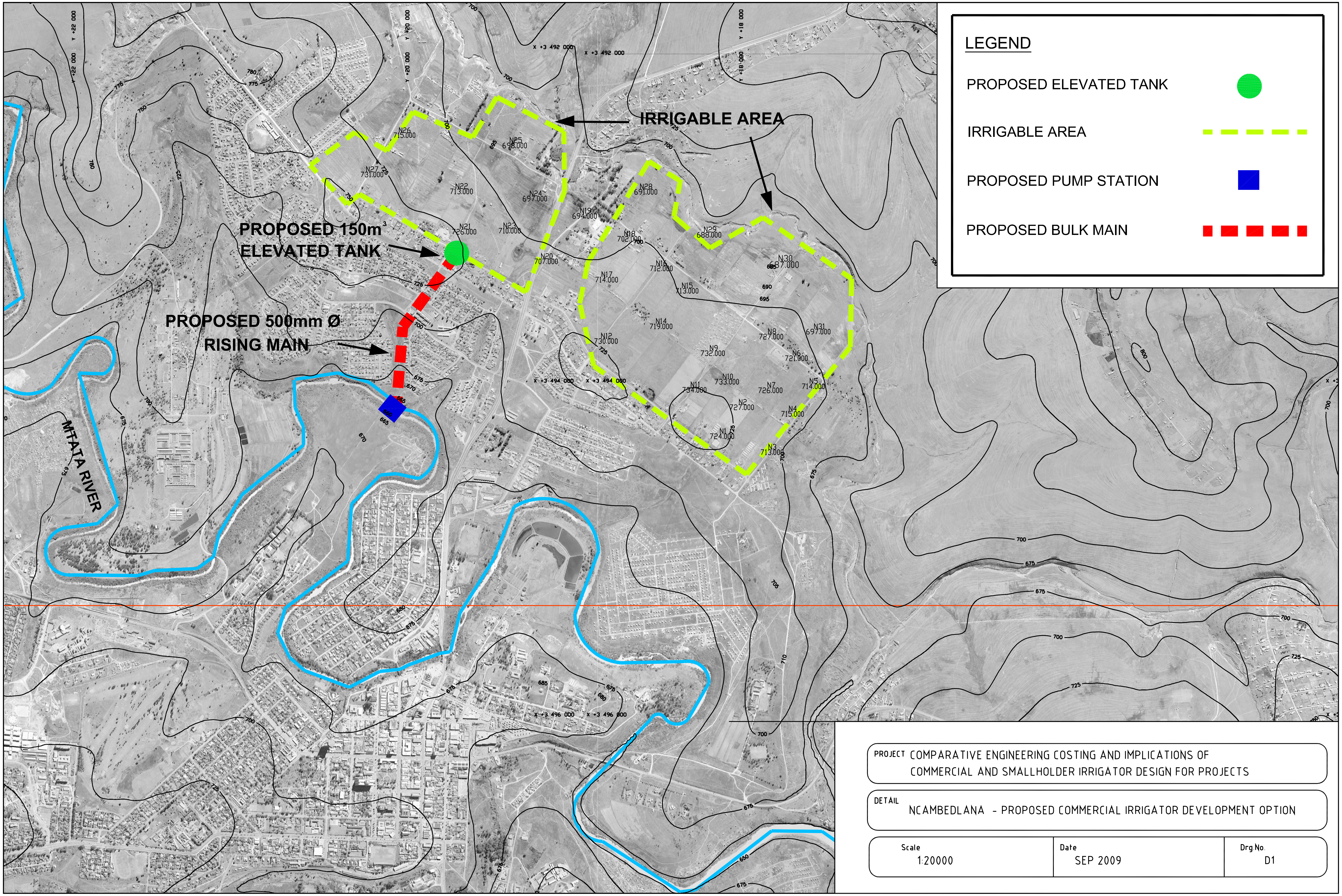
APPENDIX D
Scheme Layouts: Ncambedlana



PROJECT COMPARATIVE ENGINEERING COSTING AND IMPLICATIONS OF COMMERCIAL AND SMALLHOLDER IRRIGATOR DESIGN FOR PROJECTS		
DETAIL NCAMBEDLANA - PROPOSED COMMERCIAL IRRIGATOR DEVELOPMENT OPTION		
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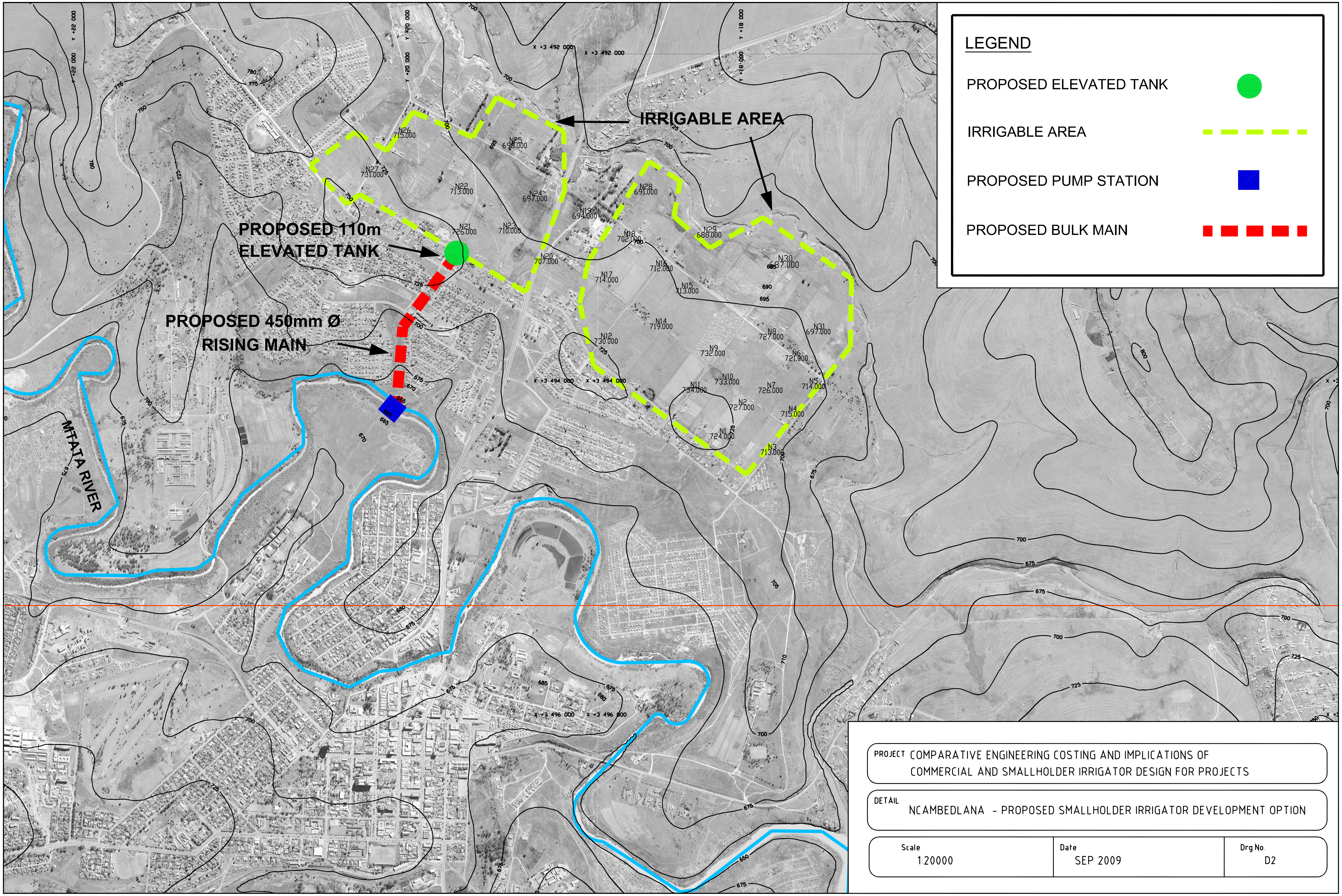

LEGEND

PROPOSED ELEVATED TANK	
IRRIGABLE AREA	
PROPOSED PUMP STATION	
PROPOSED BULK MAIN	

PROJECT COMPARATIVE ENGINEERING COSTING AND IMPLICATIONS OF COMMERCIAL AND SMALLHOLDER IRRIGATOR DESIGN FOR PROJECTS

DETAIL NCAMBEDLANA - PROPOSED SMALLHOLDER IRRIGATOR DEVELOPMENT OPTION

Scale	Date	Drg No.
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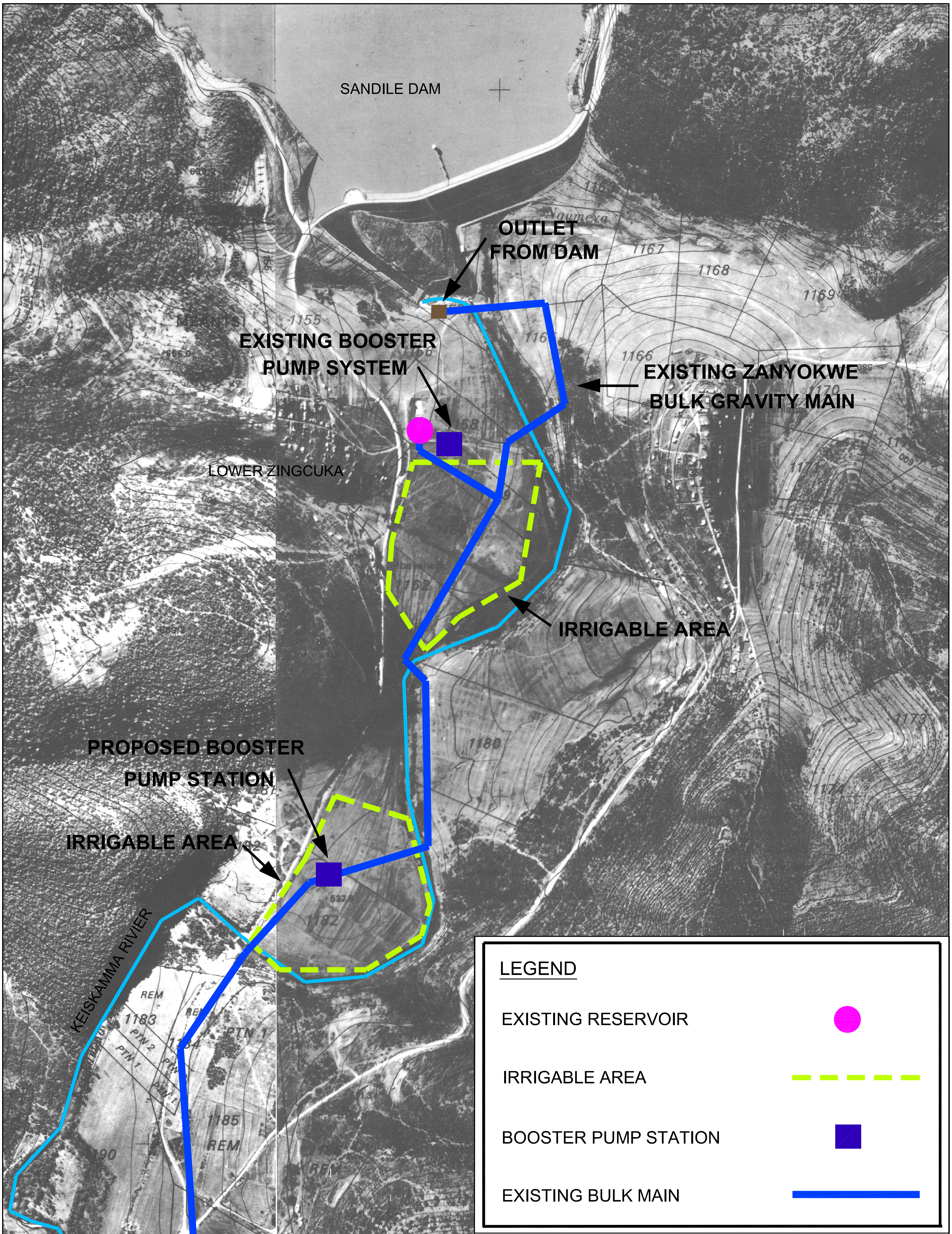
APPENDIX E
Scheme Layouts: Wolf River



PROJECT COMPARATIVE ENGINEERING COSTING AND IMPLICATIONS OF COMMERCIAL AND SMALLHOLDER IRRIGATOR DESIGN FOR PROJECTS

DETAIL WOLF RIVER - PROPOSED DEVELOPMENT OPTION

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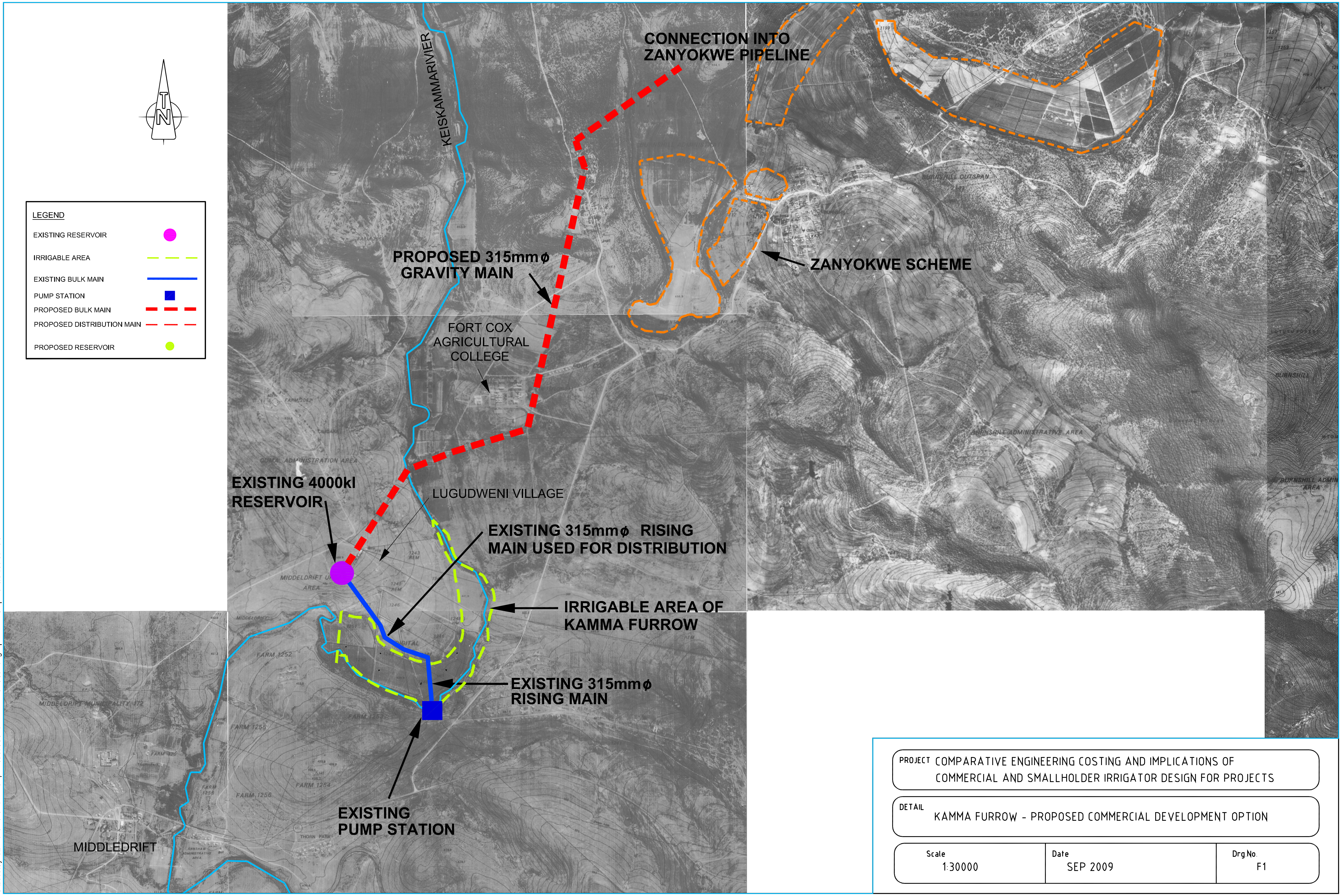
APPENDIX F
Scheme Layouts: Kama Furrow



PROJECT COMPARATIVE ENGINEERING COSTING AND IMPLICATIONS OF COMMERCIAL AND SMALLHOLDER IRRIGATOR DESIGN FOR PROJECTS		
DETAIL KAMMA FURROW - PROPOSED COMMERCIAL DEVELOPMENT OPTION		
Scale 1:30000	Date SEP 2009	Drg No. F1

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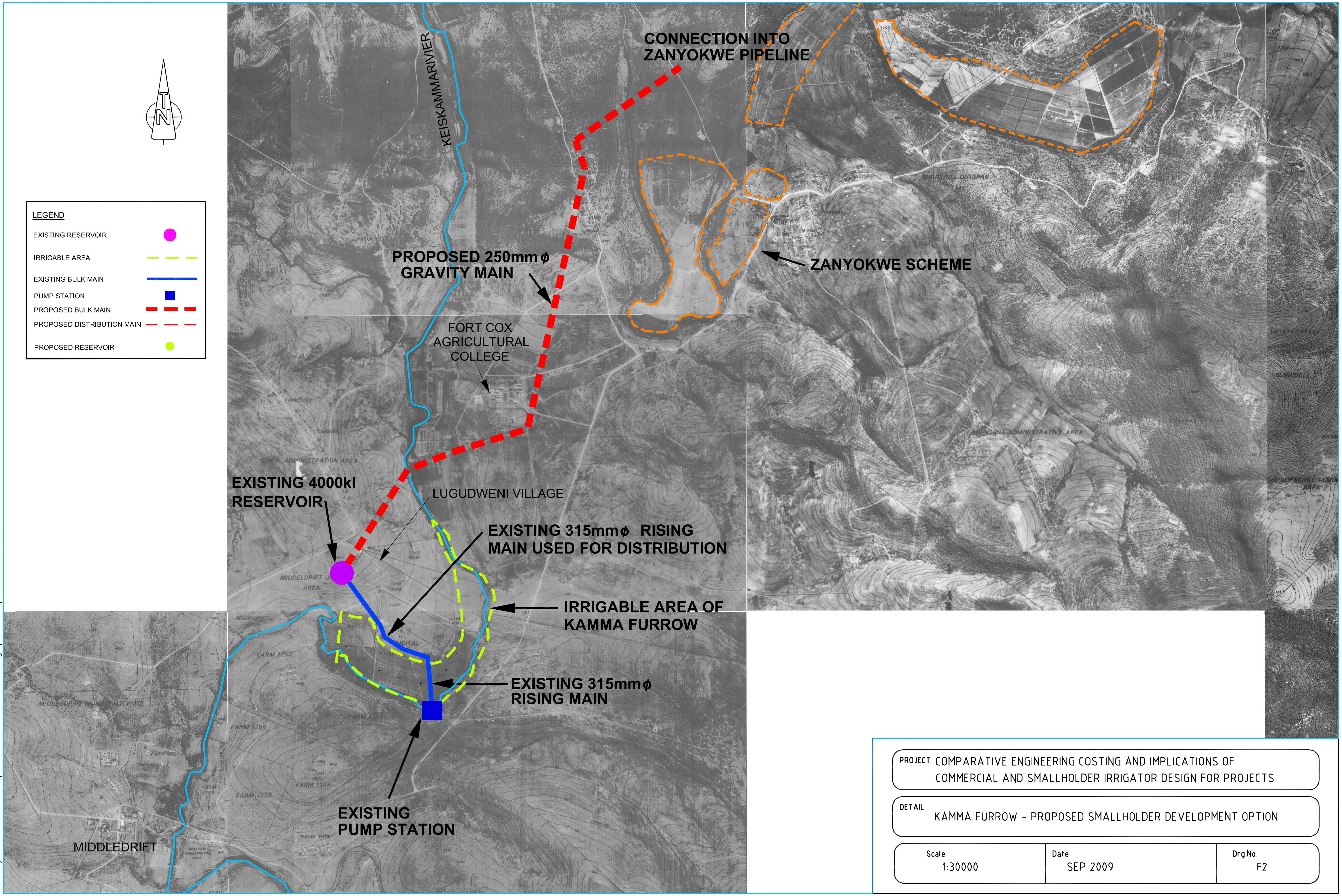
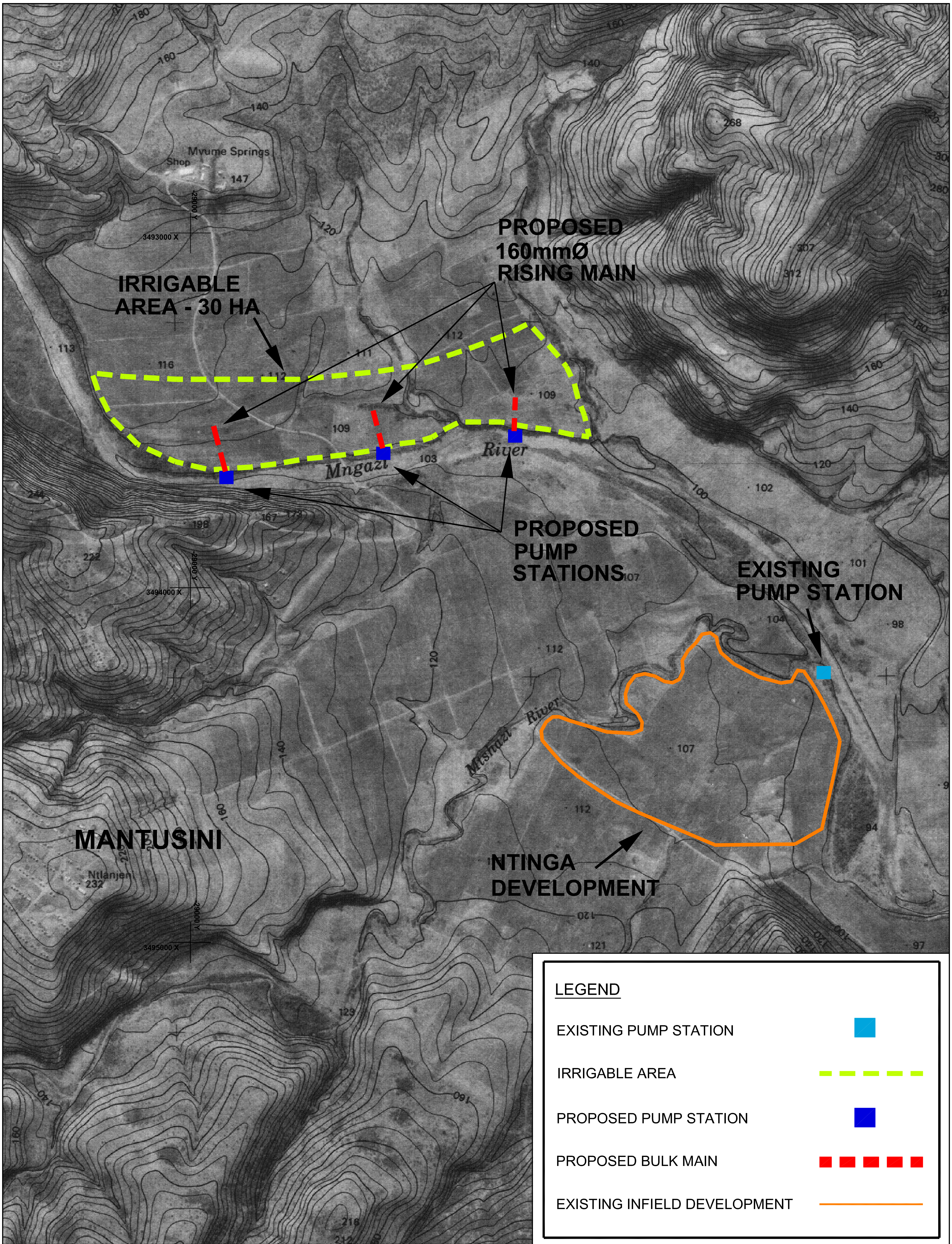


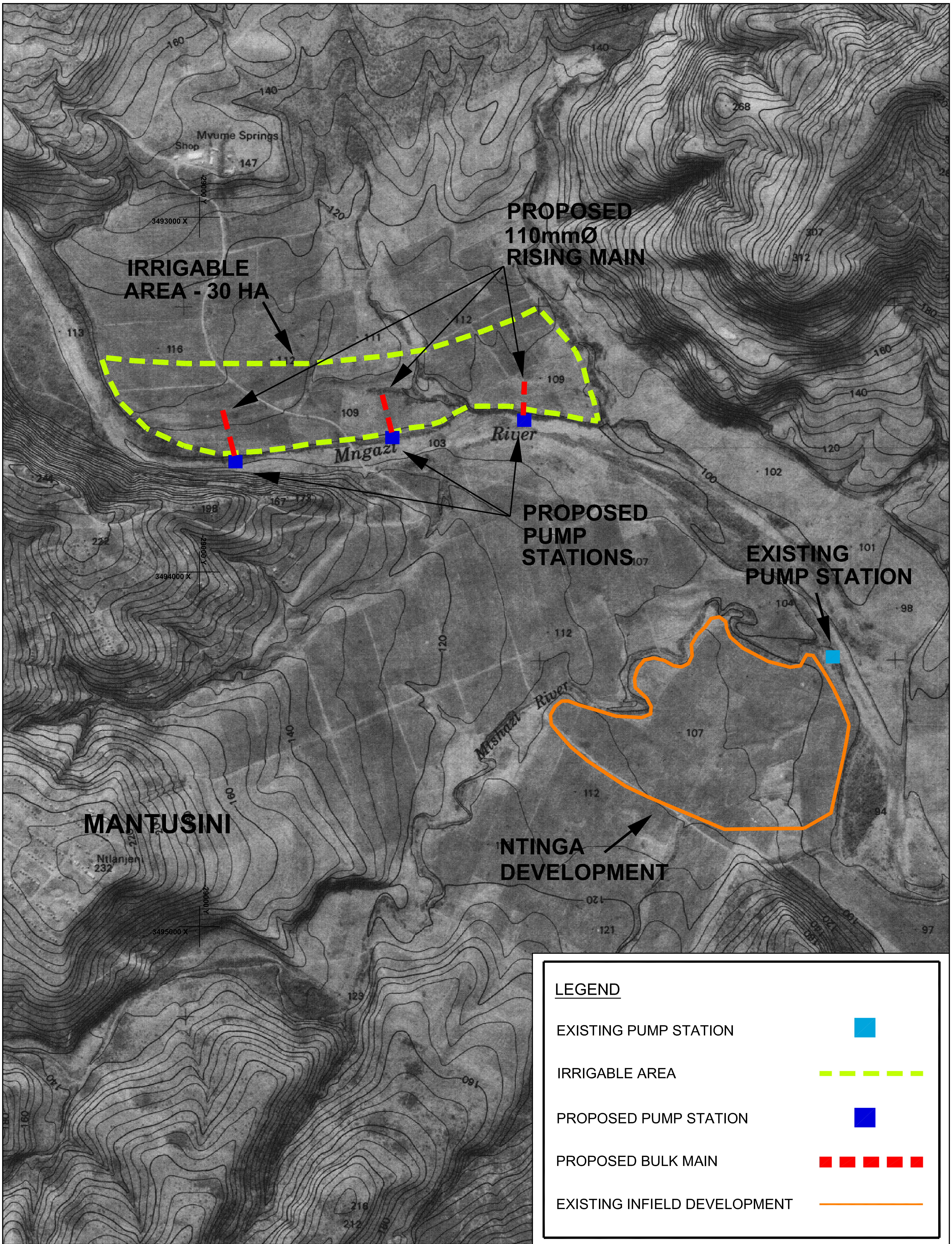
PROJECT COMPARATIVE ENGINEERING COSTING AND IMPLICATIONS OF COMMERCIAL AND SMALLHOLDER IRRIGATOR DESIGN FOR PROJECTS		
DETAIL KAMMA FURROW - PROPOSED SMALLHOLDER DEVELOPMENT OPTION		
Scale 1:30000	Date SEP 2009	Drg No. F2

APPENDIX G
Scheme Layouts: Mantusini



PROJECT	COMPARATIVE ENGINEERING COSTING AND IMPLICATIONS OF COMMERCIAL AND SMALLHOLDER IRRIGATOR DESIGN FOR PROJECTS
DETAIL	MANTUSINI - PROPOSED COMMERCIAL IRRIGATOR DEVELOPMENT OPTION

Scale	Date	Drg No.
1:10000	SEP 2009	G1



PROJECT	COMPARATIVE ENGINEERING COSTING AND IMPLICATIONS OF COMMERCIAL AND SMALLHOLDER IRRIGATOR DESIGN FOR PROJECTS
DETAIL	MANTUSINI - PROPOSED SMALLHOLDER IRRIGATOR DEVELOPMENT OPTION

Scale	Date	Drg No.
1:10000	SEP 2009	G2

APPENDIX H

Detailed Commercial LOS Capital Costing

KRUISFONTEIN - IMPROVEMENT OF WATER EFFICIENCY					
Item No.	**Description**	**Unit**	**Quantity**	**Rate**	**Total**
1	**REMEDIAL WORK ON DAMS**				
1.1	Spillway	Sum			10,000.00
1.2	Earthworks	m3	200	40	8,000.00
1.3	Sluice	Sum			15,000.00
2	**CHANNELS**				
2.1	Trapezoidal Concrete	lin. m	609	15	9,135.00
2.2	Diversion Boxes	No	11	1,500	16,500.00
3	**PIPELINES**				
3.1	Distribution Mains (160 dia, MPVC)	lin. m	551	199	109,649.00
3.2	Distribution Mains (110 dia, HDPE)	lin. m	454	116	52,664.00
3.3	Distribution Mains (90 dia, HDPE)	lin. m	884	98	87,073.23
3.4	Distribution Mains (75 dia, HDPE)	lin. m	713	80	57,040.00
3.5	Distribution Mains (63 dia, HDPE)	lin. m	850	60	51,347.61
3.6	Distribution Mains (50 dia, HDPE)	lin. m	364	50	18,214.37
3.7	Distribution Mains (40 dia, HDPE)	lin. m	179	44	7,829.02
4	**INFIELD**	ha	0	19,441	0.00
	SUBTOTAL FOR CONSTRUCTION				**442,452.22**
5	**CONTINGENCIES**				
5.1	Preliminaries and General Items		% of subtotal	15%	66,367.83
5.2	Physical Contingencies		% of subtotal	10%	44,245.22
6	**FINAL DESIGN AND CONSTRUCTION SUPERVISION**				
6.1	Basic Design Cost (% of capital cost)		% of subtotal	5.0%	27,653.26
6.2	Tender Services & Construction Supervision (% of capital cost)		% of subtotal	11.0%	60,837.18
	TOTAL PROJECT COST				**641,555.72**

TAMBOEKIESVLEI DEVLOPMENT OF ON-SITE DAM					
Item No.	**Description**	**Unit**	**Quantity**	**Rate**	**Total**
1	**DAM**				
1.1	Embankment	m3	17,480	108	1,641,600.00
1.2	Spillway				
1.2.1	Excavation	m3	4,085	40	142,086.96
1.2.2	Concrete Lining	m3	22	4,000	74,782.61
1.3	Access Roads	km	0	816,840	0.00
1.4	Supply of Electrical Line	km	0	72,000	0.00
2	**OUTLET WORKS FROM DAM**	sum			30,000.00
3	**PIPELINE**				
3.1	Gravity Main (250 dia, PVC)	lin. m	1,500	611	915,929.56
3.2	Distribution Main (160 dia, PVC)	lin. m	400	199	79,600.00
3.3	Distribution Main (110 dia, PVC)	lin. m	200	117	23,400.00
3.4	Distribution Main (75 dia, PVC)	lin. m	400	79	31,600.00
3.5	Distribution Main (63 dia, PVC)	lin. m	1,200	75	90,000.00
4	**INFIELD**	ha	33.84	18,000	609,120.00
	SUBTOTAL FOR CONSTRUCTION				**3,638,119.13**
5	**CONTINGENCIES**				
5.1	Preliminaries and General Items		% of subtotal	15%	545,717.87
5.2	Physical Contingencies		% of subtotal	10%	363,811.91
6	**FINAL DESIGN AND CONSTRUCTION**				
	SUPERVISION				
6.1	Basic Design Cost (% of capital cost)		% of subtotal	5.0%	227,382.45
6.2	Tender Services & Construction Supervision (% of		% of subtotal	11.0%	500,241.38
	capital cost)				
	TOTAL PROJECT COST				**5,275,272.74**

NCAMBEDLANA - PHASE TO ACCOMMODATE 85HA					
Item No.	**Description**	**Unit**	**Quantity**	**Rate**	**Total**
1	**DIVERSION WORKS ON UMTATA RIVER**				
1.1	Reinforced Concrete	m3	11	4,000	44,000.00
1.2	Mass Concrete	m3	30	2,700	81,000.00
2	**PUMP STATION ON UMTATA RIVER**				
2.1	Electrical & Mechanical Components	sum			1,710,000.00
2.2	Supply of Electrical Line	km	1.23	72,000	76,695.65
3	**ELEVATED TANK**	kl	150		1,155,750.00
4	**PIPELINES**				
4.1	Rising Main (500 dia, Steel)	lin. m	1,050	1,731	1,817,699.39
4.2	Distribution Mains (400 dia, Steel)	lin. m	270	1,300	351,000.00
5	**INFIELD**	ha	85	25,900	2,201,500.00
	SUBTOTAL FOR CONSTRUCTION				**7,437,645.05**
6	**CONTINGENCIES**				
6.1	Preliminaries and General Items		% of subtotal	15%	1,115,646.76
6.2	Physical Contingencies		% of subtotal	10%	743,764.50
7	**FINAL DESIGN AND CONSTRUCTION**				
	SUPERVISION				
7.1	Basic Design Cost (% of capital cost)		% of subtotal	5.0%	464,852.82
7.2	Tender Services & Construction Supervision (% of		% of subtotal	11.0%	1,022,676.19
	capital cost)				
	TOTAL PROJECT COST				**10,784,585.32**

WOLF RIVER: REFURBISHMENT OF EXISTING ZANYOKWE SECTION					
Item No.	**Description**	**Unit**	**Quantity**	**Rate**	**Total**
1	**BOOSTER PUMP STATION**				
1.1	Civil, Electrical & Mechanical Components	No	1	78,000	78,000.00
1.2	Reconnection of Eskom supply	No	1	10,000	10,000.00
2	**FENCING**	m	3,250	100	325,000.00
3	**INFIELD**				
3.1	Refurbishment	ha	12	9,400	112,800.00
3.2	New Infrastructure	ha	12	19,441	233,286.46
	SUBTOTAL FOR CONSTRUCTION				**759,086.46**
4.2	**CONTINGENCIES**				
4.3	Preliminaries and General Items		% of subtotal	15%	113,862.97
4.4	Physical Contingencies		% of subtotal	10%	75,908.65
5.2	**FINAL DESIGN AND CONSTRUCTION**				
	SUPERVISION				
5.3	Basic Design Cost (% of capital cost)		% of subtotal	5.0%	47,442.90
5.4	Tender Services & Construction Supervision (% of		% of subtotal	11.0%	104,374.39
	capital cost)				
	TOTAL PROJECT COST				**1,100,675.36**

KAMA FURROW - Extension of the Bulk Line to Kama Furrow					
Item No.	**Description**	**Unit**	**Quantity**	**Rate**	**Total**
1	**RESERVOIR**	m3	0	1,100	0.00
2	**PIPELINES**				
2.1	Gravity Main (315 dia, MPVC)	lin. m	7,550	611	4,610,178.81
2.2	River Crossing	No	1	50,000	50,000.00
3	**FENCING**	m	6,139	100	613,900.00
4	**INFIELD**	ha	51	9,400	478,460.00
	SUBTOTAL FOR CONSTRUCTION				**5,752,538.81**
5	**CONTINGENCIES**				
5.1	Preliminaries and General Items		% of subtotal	15%	862,880.82
5.2	Physical Contingencies		% of subtotal	10%	575,253.88
6	**FINAL DESIGN AND CONSTRUCTION SUPERVISION**				
6.1	Basic Design Cost (% of capital cost)		% of subtotal	5.0%	359,533.68
6.2	Tender Services & Construction Supervision (% of capital cost)		% of subtotal	11.0%	790,974.09
	TOTAL PROJECT COST				**8,341,181.27**

MANTUSINI – PUMPING TO FIELD EDGE					
Item No.	**Description**	**Unit**	**Quantity**	**Rate**	**Total**
1	**PUMP STATION AT RIVER**				
1.1	Electrical & Mechanical Components	sum			249,300.00
1.2	Supply of Electrical Line	km	6.00	72,000	432,000.00
2	**RESERVOIR**	m3	0	1,100	0.00
3	**PIPELINES**				
3.1	3 x Rising Mains (160 dia, MPVC)	lin. m	900	224	201,712.98
3.2	Distribution Mains	lin. m	0	224	0.00
4	**INFIELD**	ha	30	25,800	774,000.00
	SUBTOTAL FOR CONSTRUCTION				**1,657,012.98**
5	**CONTINGENCIES**				
5.1	Preliminaries and General Items		% of subtotal	15%	248,551.95
5.2	Physical Contingencies		% of subtotal	10%	165,701.30
6	**FINAL DESIGN AND CONSTRUCTION**				
	SUPERVISION				
6.1	Basic Design Cost (% of capital cost)		% of subtotal	5.0%	103,563.31
6.2	Tender Services & Construction Supervision (% of		% of subtotal	11.0%	227,839.29
	capital cost)				
	TOTAL PROJECT COST				**2,402,668.83**

APPENDIX I

Detailed Smallholder LOS Capital Costing

KRUISFONTEN - IMPROVEMENT OF WATER EFFICIENCY					
Item No.	**Description**	**Unit**	**Quantity**	**Rate**	**Total**
1	**REMEDIAL WORK ON DAMS**				
1.1	Spillway	Sum			10,000.00
1.2	Earthworks	m3	200	40	8,000.00
1.3	Sluice	Sum			15,000.00
2	**CHANNELS**				
2.1	Trapezoidal Concrete	lin. m	609	15	9,135.00
2.2	Diversion Boxes	No	11	1,500	16,500.00
3	**PIPELINES**				
3.1	Distribution Mains (160 dia, MPVC)	lin. m	0	199	0.00
3.2	Distribution Mains (110 dia, HDPE)	lin. m	0	116	0.00
3.3	Distribution Mains (90 dia, HDPE)	lin. m	551	98	54,273.02
3.4	Distribution Mains (75 dia, HDPE)	lin. m	620	80	49,600.00
3.5	Distribution Mains (63 dia, HDPE)	lin. m	842	60	50,864.33
3.6	Distribution Mains (50 dia, HDPE)	lin. m	1,571	50	78,612.04
3.7	Distribution Mains (40 dia, HDPE)	lin. m	438	44	19,157.03
4	**INFIELD**	ha	0	18,400	0.00
	SUBTOTAL FOR CONSTRUCTION				**311,141.42**
5	**CONTINGENCIES**				
5.1	Preliminaries and General Items		% of subtotal	15%	46,671.21
5.2	Physical Contingencies		% of subtotal	10%	31,114.14
6	**FINAL DESIGN AND CONSTRUCTION**				
	SUPERVISION				
6.1	Basic Design Cost (% of capital cost)		% of subtotal	5.0%	19,446.34
6.2	Tender Services & Construction Supervision (% of		% of subtotal	11.0%	42,781.95
	capital cost)				
	TOTAL PROJECT COST				**451,155.06**

TAMBOEKIESVLEI DEVLOPMENT OF ON-SITE DAM					
Item No.	**Description**	**Unit**	**Quantity**	**Rate**	**Total**
1	**DAM**				
1.1	Embankment	m3	9,635	108	904,816.96
1.2	Spillway				
1.2.1	Excavation	m3	2,734	40	95,078.26
1.2.2	Concrete Lining	m3	18	4,000	61,739.13
1.3	Access Roads	km	0	816,840	0.00
1.4	Supply of Electrical Line	km	0	75,000	0.00
2	**OUTLET WORKS FROM DAM**	sum			30,000.00
3	**PIPELINE**				
3.1	Gravity Main (200 dia, PVC)	lin. m	1,500	327	489,848.08
3.2	Distribution Main (160 dia, PVC)	lin. m	400	199	79,600.00
3.3	Distribution Main (110 dia, PVC)	lin. m	200	117	23,400.00
3.4	Distribution Main (75 dia, PVC)	lin. m	400	79	31,600.00
3.5	Distribution Main (63 dia, PVC)	lin. m	1,200	75	90,000.00
4	**INFIELD**	ha	33.84	18,000	609,120.00
	SUBTOTAL FOR CONSTRUCTION				**2,415,202.43**
5	**CONTINGENCIES**				
5.1	Preliminaries and General Items		% of subtotal	15%	362,280.36
5.2	Physical Contingencies		% of subtotal	10%	241,520.24
6	**FINAL DESIGN AND CONSTRUCTION**				
	SUPERVISION				
6.1	Basic Design Cost (% of capital cost)		% of subtotal	5.0%	150,950.15
6.2	Tender Services & Construction Supervision (% of		% of subtotal	11.0%	332,090.33
	capital cost)				
	TOTAL PROJECT COST				**3,502,043.53**

NCAMBEDLANA - PHASE TO ACCOMMODATE 85HA					
Item No.	**Description**	**Unit**	**Quantity**	**Rate**	**Total**
1	**DIVERSION WORKS ON UMTATA RIVER**				
1.1	Reinforced Concrete	m3	11	4,000	44,000.00
1.2	Mass Concrete	m3	30	2,700	81,000.00
2	**PUMP STATION ON UMTATA RIVER**				
2.1	Electrical & Mechanical Components	sum			1,231,200.00
2.2	Supply of Electrical Line	km	1.23	75,000	79,891.30
3	**ELEVATED TANK**	kl	110		1,023,500.00
4	**PIPELINES**				
4.1	Rising Main (450 dia, Steel)	lin. m	1,050	1,565	1,643,694.62
4.2	Distribution Mains (355 dia, PVC)	lin. m	270	1,100	297,000.00
5	**INFIELD**	ha	85	23,200	1,972,000.00
	SUBTOTAL FOR CONSTRUCTION				**6,372,285.92**
6	**CONTINGENCIES**				
6.1	Preliminaries and General Items		% of subtotal	15%	955,842.89
6.2	Physical Contingencies		% of subtotal	10%	637,228.59
7	**FINAL DESIGN AND CONSTRUCTION**				
	SUPERVISION				
7.1	Basic Design Cost (% of capital cost)		% of subtotal	5.0%	398,267.87
7.2	Tender Services & Construction Supervision (% of		% of subtotal	11.0%	876,189.31
	capital cost)				
	TOTAL PROJECT COST				**9,239,814.59**

WOLF RIVER: REFURBISHMENT OF EXISTING ZANYOKWE SECTION					
Item No.	**Description**	**Unit**	**Quantity**	**Rate**	**Total**
1	**BOOSTER PUMP STATION**				
1.1	Civil, Electrical & Mechanical Components	No	1	63,000	63,000.00
1.2	Reconnection of Eskom supply	No	1	10,000	10,000.00
2	**FENCING**	m	3,250	100	325,000.00
3	**INFIELD**				
3.1	Refurbishment	ha	12	9,400	112,800.00
3.2	New Infrastructure	ha	12	18,400	220,800.00
	SUBTOTAL FOR CONSTRUCTION				**731,600.00**
4.2	**CONTINGENCIES**				
4.3	Preliminaries and General Items		% of subtotal	15%	109,740.00
4.4	Physical Contingencies		% of subtotal	10%	73,160.00
5.2	**FINAL DESIGN AND CONSTRUCTION**				
	SUPERVISION				
5.3	Basic Design Cost (% of capital cost)		% of subtotal	5.0%	45,725.00
5.4	Tender Services & Construction Supervision (% of		% of subtotal	11.0%	100,595.00
	capital cost)				
	TOTAL PROJECT COST				**1,060,820.00**

KAMA FURROW - Extension of the Bulk Line to Kama Furrow					
Item No.	**Description**	**Unit**	**Quantity**	**Rate**	**Total**
1	**RESERVOIR**	m3	0	1,100	0.00
2	**PIPELINES**				
2.1	Gravity Main (250 dia, MPVC)	lin. m	7,550	485	3,662,822.48
2.2	River Crossing	No	1	50,000	50,000.00
3	**FENCING**	m	6,139	100	613,900.00
4	**INFIELD**	ha	51	9,400	478,460.00
	SUBTOTAL FOR CONSTRUCTION				**4,805,182.48**
5	**CONTINGENCIES**				
5.1	Preliminaries and General Items		% of subtotal	15%	720,777.37
5.2	Physical Contingencies		% of subtotal	10%	480,518.25
6	**FINAL DESIGN AND CONSTRUCTION**				
	SUPERVISION				
6.1	Basic Design Cost (% of capital cost)		% of subtotal	5.0%	300,323.90
6.2	Tender Services & Construction Supervision (% of		% of subtotal	11.0%	660,712.59
	capital cost)				
	TOTAL PROJECT COST				**6,967,514.59**

MANTUSINI – PUMPING TO FIELD EDGE					
Item No.	**Description**	**Unit**	**Quantity**	**Rate**	**Total**
1	**PUMP STATION AT RIVER**				
1.1	Electrical & Mechanical Components	sum			252,000.00
1.2	Supply of Electrical Line	km	6.00	75,000	450,000.00
2	**RESERVOIR**	m3	0	1,100	0.00
3	**PIPELINES**				
3.1	3 x Rising Mains (110 dia, MPVC)	lin. m	900	123	110,942.51
3.2	Distribution Mains	lin. m	0	123	0.00
4	**INFIELD**	ha	30	22,800	684,000.00
	SUBTOTAL FOR CONSTRUCTION				**1,496,942.51**
5	**CONTINGENCIES**				
5.1	Preliminaries and General Items		% of subtotal	15%	224,541.38
5.2	Physical Contingencies		% of subtotal	10%	149,694.25
6	**FINAL DESIGN AND CONSTRUCTION**				
	SUPERVISION				
6.1	Basic Design Cost (% of capital cost)		% of subtotal	5.0%	93,558.91
6.2	Tender Services & Construction Supervision (% of		% of subtotal	11.0%	205,829.59
	capital cost)				
	TOTAL PROJECT COST				**2,170,566.64**

APPENDIX J
Commercial LOS O&M Costs

KRUISFONTEIN - Operation and Maintenance Costs

Construction Costs	(R x 1000)	Civil	M&E	Total
Dams		41		41
Channels		32		32
Pipelines		480		480
Infield				
construction subtotal		553		553
Design & Supervision fees - 16%		88		88
Total for new costs		642		642
Total for O&M		553		
Maintenance Costs				
Annual O&M Costs		0.5%	4.0%	
		3.2		
Life of investment costs		40	10	
Residual Value (20 yrs)		25%		
Additional Unit Costs		30		
Catchment Management Agency R/h				
Water User Association R/ha				
Water levy (cents/cu.m)		0.67		
	sub-total	0.67		29.53
Energy Costs				
	Head (m)	Max Flow (l's)	Pump Eff'y	Motor Eff'y
			80%	85%
maximum kVA		load factor	0.9	
average number of hours a year				1,045
average maximum demand (kW)				
Energy costs	(R x 1000)			
Personnel		Attendants	Labourer	Total
Dam				
Grade Salary/yr x Rx1000		48	24	
Costs inc admin...	50%			
Vehicles	(R x 1000)	Heavy plant	Light Vehicles	Total
Total cost				
Maintenance at 10%				
Running costs km/annum				
km/l			10	
unit cost of fuel (diesel) R / litre	4.00			
Cost per year				
Life (year)		10	6	

Annual Operation and Maintenance Costs

Year	Investment costs			Maintenance costs			Operational costs					Total	Water
	Civil R x1000	M&E Rx1000	Total Rx1000	Civil Rx1000	M&E Rx1000	Total Rx1000	Add.Costs Rx1000	Energy Rx1000	Personnel Rx1000	Vehicles Rx1000	Total Rx1000	Overall Costs	Supplied M m3
2007	256.622		256.622									256.622	
2008	256.622		256.622									256.622	
2009	128.311		128.311									128.311	
2010				3.208		3.208	0.886				0.886	4.094	0.132
2011				3.208		3.208	0.886				0.886	4.094	0.132
2012				3.208		3.208	0.886				0.886	4.094	0.132
2013				3.208		3.208	0.886				0.886	4.094	0.132
2014				3.208		3.208	0.886				0.886	4.094	0.132
2015				3.208		3.208	0.886				0.886	4.094	0.132
2016				3.208		3.208	0.886				0.886	4.094	0.132
2017				3.208		3.208	0.886				0.886	4.094	0.132
2018				3.208		3.208	0.886				0.886	4.094	0.132
2019				3.208		3.208	0.886				0.886	4.094	0.132
2020				3.208		3.208	0.886				0.886	4.094	0.132
2021				3.208		3.208	0.886				0.886	4.094	0.132
2022				3.208		3.208	0.886				0.886	4.094	0.132
2023				3.208		3.208	0.886				0.886	4.094	0.132
2024				3.208		3.208	0.886				0.886	4.094	0.132
2025				3.208		3.208	0.886				0.886	4.094	0.132
2026				3.208		3.208	0.886				0.886	4.094	0.132
2027				3.208		3.208	0.886				0.886	4.094	0.132
2028				3.208		3.208	0.886				0.886	4.094	0.132
2029	-160.389		-160.389	3.208		3.208	0.886				0.886	-156.295	0.132
			481.167			64.156					17.720	1,108.365	

TAMBOEKIESVLEI - Construction of Dam - Operation and Maintenance Costs

Construction Costs		(R x 1000)	Civil	M&E	Total
Dam			2,323		2,323
Outlet Works from Dam			38		38
Pipelines			1,426		1,426
Infield			761		761
	construction subtotal		4,548		4,548
Design & Supervision fees - 16%			728		728
Total for new costs			5,275		5,275
Total for O&M			4,548		
Maintenance Costs					
Annual O&M Costs			0.5%	4.0%	
Dam			0.25%		
			19.64		
Life of investment costs			40	10	
Residual Value (20 yrs)			25%		
Additional Unit Costs			29		
Catchment Management Agency R/h					
Water User Association R/ha		250			
Water levy (cents/cu.m)			0.67		
		sub-total	0.67		63.28
Energy Costs					
		Head (m)	Max Flow (l's)	Pump Eff'y	Motor Eff'y
		30	28	80%	85%
maximum kVA			load factor	0.9	12
average number of hours a year					
average maximum demand (kW)					11
Energy costs		(R x 1000)			
Personnel			Attendants	Labourer	Total
Dam					
Grade Salary/yr x Rx1000			48	24	
Costs	inc admin...	50%			
Vehicles		(R x 1000)	Heavy plant	Light Vehicles	Total
Total cost					
Maintenance at	10%				
Running costs	km/annum				
	km/l			10	
unit cost of fuel (diesel)	R / litre	4.00			
Cost per year					
Life (year)			10	6	

Annual Operation and Maintenance Costs

Year	Investment costs			Maintenance costs			Operational costs					Total	Water
	Civil R x1000	M&E Rx1000	Total Rx1000	Civil Rx1000	M&E Rx1000	Total Rx1000	Add.Costs Rx1000	Energy Rx1000	Personnel Rx1000	Vehicles Rx1000	Total Rx1000	Overall Costs	Supplied M m3
2007	2,110.109		2,110.109									2,110.109	
2008	2,110.109		2,110.109									2,110.109	
2009	1,055.055		1,055.055									1,055.055	
2010				19.639		19.639	1.835				1.835	21.475	0.274
2011				19.639		19.639	1.835				1.835	21.475	0.274
2012				19.639		19.639	1.835				1.835	21.475	0.274
2013				19.639		19.639	1.835				1.835	21.475	0.274
2014				19.639		19.639	1.835				1.835	21.475	0.274
2015				19.639		19.639	1.835				1.835	21.475	0.274
2016				19.639		19.639	1.835				1.835	21.475	0.274
2017				19.639		19.639	1.835				1.835	21.475	0.274
2018				19.639		19.639	1.835				1.835	21.475	0.274
2019				19.639		19.639	1.835				1.835	21.475	0.274
2020				19.639		19.639	1.835				1.835	21.475	0.274
2021				19.639		19.639	1.835				1.835	21.475	0.274
2022				19.639		19.639	1.835				1.835	21.475	0.274
2023				19.639		19.639	1.835				1.835	21.475	0.274
2024				19.639		19.639	1.835				1.835	21.475	0.274
2025				19.639		19.639	1.835				1.835	21.475	0.274
2026				19.639		19.639	1.835				1.835	21.475	0.274
2027				19.639		19.639	1.835				1.835	21.475	0.274
2028				19.639		19.639	1.835				1.835	21.475	0.274
2029	-1,318.818		-1,318.818	19.639		19.639	1.835				1.835	-1,297.344	0.274
			3,956.455			392.788					36.703	8,735.188	

UMTATA - Phased serving 1/2 the area (Pumping from Umtata River) - Operation and Maintenance Costs

Construction Costs		(R x 1000)	Civil	M&E	Total
Diversion Works			156		156
Pump Station				2,233	2,233
Pipelines			2,711		2,711
Elevated Tank			1,445		1,445
Infield			2,752		2,752
	construction subtotal		7,064	2,233	9,297
Design & Supervision fees - 16%			1,130	357	1,488
Total for new costs			8,194	2,591	10,785
Maintenance Costs					
Annual O&M Costs			0.5%	4.0%	
			41.0	103.6	
Life of investment costs			40	10	
Residual Value (20 yrs)			20%		
Additional Unit Costs			85		
Catchment Management Agency R/ha					
Water User Association R/ha		250	21,250		
Water levy (cents/cu.m)			0.67		
		sub-total	0.67		49.05
Energy Costs					
		Head (m)	Max Flow (l's)	Pump Eff'y	Motor Eff'y
		115	276	82%	85%
maximum kVA			load factor	0.9	499
average number of hours a year					945
average maximum demand (kW)					449
Energy costs		(R x 1000)			827.36
Personnel			Attendants	Labourer	Total
Pump Station / Pipeline					
Grade Salary/yr x Rx1000			48	24	
Costs	inc admin...	50%			
Vehicles		(R x 1000)	Heavy plant	Light Vehicles	Total
Total cost					
Maintenance at	10%				
Running costs	km/annum				
	km/l			10	
unit cost of fuel (diesel)	R / litre	4.00			
Cost per year					
Life (year)			10	6	

Annual Operation and Maintenance Costs

Year	**Investment costs** Civil R x1000	M&E Rx1000	Total Rx1000	**Maintenance costs** Civil Rx1000	M&E Rx1000	Total Rx1000	**Operational costs** Add.Costs Rx1000	Energy Rx1000	Personnel Rx1000	Vehicles Rx1000	Total Rx1000	Total Overall Costs	Water Supplied M m3
2007	3,277.551		3,277.551									3,277.551	
2008	3,277.551	1,295.354	4,572.905									4,572.905	
2009	1,638.775	1,295.354	2,934.130									2,934.130	
2010				40.969	103.628	144.598	25.419	827.365			852.784	997.381	0.62
2011				40.969	103.628	144.598	25.419	827.365			852.784	997.381	0.62
2012				40.969	103.628	144.598	25.419	827.365			852.784	997.381	0.62
2013				40.969	103.628	144.598	25.419	827.365			852.784	997.381	0.62
2014				40.969	103.628	144.598	25.419	827.365			852.784	997.381	0.62
2015				40.969	103.628	144.598	25.419	827.365			852.784	997.381	0.62
2016				40.969	103.628	144.598	25.419	827.365			852.784	997.381	0.62
2017				40.969	103.628	144.598	25.419	827.365			852.784	997.381	0.62
2018				40.969	103.628	144.598	25.419	827.365			852.784	997.381	0.62
2019		2,590.709	2,590.709	40.969	103.628	144.598	25.419	827.365			852.784	3,588.090	0.62
2020				40.969	103.628	144.598	25.419	827.365			852.784	997.381	0.62
2021				40.969	103.628	144.598	25.419	827.365			852.784	997.381	0.62
2022				40.969	103.628	144.598	25.419	827.365			852.784	997.381	0.62
2023				40.969	103.628	144.598	25.419	827.365			852.784	997.381	0.62
2024				40.969	103.628	144.598	25.419	827.365			852.784	997.381	0.62
2025				40.969	103.628	144.598	25.419	827.365			852.784	997.381	0.62
2026				40.969	103.628	144.598	25.419	827.365			852.784	997.381	0.62
2027				40.969	103.628	144.598	25.419	827.365			852.784	997.381	0.62
2028				40.969	103.628	144.598	25.419	827.365			852.784	997.381	0.62
2029				40.969	103.628	144.598	25.419	827.365			852.784	997.381	0.62
			13,375.294			2,891.955					17,055.673	33,322.922	

Wolf River - (Refurbishment of Existing Zanyokwe Section) - Operation and Maintenance Costs

Construction Costs	(R x 1000)	Civil	M&E	Total
Existing Infrastructure				
Reservoir		1,375		1,375
Pipelines		90		90
Infield		292		292
Total of Existing Infrastructure		1,465		1,465
Refurbishment				
Booster Pump Station		13	98	110
Fencing		406		406
Infield		433		433
construction subtotal		851	98	949
Design & Supervision fees - 16%		136	16	152
Total for new costs		988	98	1,101
Total for O&M costs		2,453	98	2,566
Maintenance Costs				
Annual O&M Costs		0.5%	4.0%	
Reservoir		1.0%		
		19.14	3.9	
Life of investment costs		40	10	
Residual Value (20 yrs)		20%		
Additional Unit Costs		25		
Catchment Management Agency R/h				
Water User Association R/ha	250	6,250		
Water levy (cents/cu.m)		0.67		
	sub-total	0.67		57.13
Energy Costs				
	Head (m)	Max Flow (l's)	Pump Eff'y	Motor Eff'y
	30	30	77%	85%
maximum kVA		load factor	0.9	15
average number of hours a year				
average maximum demand (kW)				13
Energy costs	(R x 1000)			32.46
Personnel		Attendants	Labourer	Total
Pump Station / Dam / Pipeline				
Grade Salary/yr x Rx1000		48	24	
Costs inc admin...	50%			
Vehicles	(R x 1000)	Heavy plant	Light Vehicles	Total
Total cost				
Maintenance at 10%				
Running costs km/annum				
km/l			10	
unit cost of fuel (diesel) R / litre	4.50			
Cost per year				
Life (year)		10	6	

Annual Operation and Maintenance Costs

Year	**Investment costs**			**Maintenance costs**			**Operational costs**					Total	Water
	Civil R x1000	M&E Rx1000	Total Rx1000	Civil Rx1000	M&E Rx1000	Total Rx1000	Add.Costs Rx1000	Energy Rx1000	Personnel Rx1000	Vehicles Rx1000	Total Rx1000	Overall Costs	Supplied k m3
2005													
2006													
2007	987.575		987.575									987.575	
2008				19.138	3.900	23.038	7.678	32.460			40.138	63.176	213.188
2009				19.138	3.900	23.038	7.678	32.460			40.138	63.176	213.188
2010				19.138	3.900	23.038	7.678	32.460			40.138	63.176	213.188
2011				19.138	3.900	23.038	7.678	32.460			40.138	63.176	213.188
2012				19.138	3.900	23.038	7.678	32.460			40.138	63.176	213.188
2013				19.138	3.900	23.038	7.678	32.460			40.138	63.176	213.188
2014				19.138	3.900	23.038	7.678	32.460			40.138	63.176	213.188
2015				19.138	3.900	23.038	7.678	32.460			40.138	63.176	213.188
2016				19.138	3.900	23.038	7.678	32.460			40.138	63.176	213.188
2017		97.500	97.500	19.138	3.900	23.038	7.678	32.460			40.138	160.676	213.188
2018				19.138	3.900	23.038	7.678	32.460			40.138	63.176	213.188
2019				19.138	3.900	23.038	7.678	32.460			40.138	63.176	213.188
2020				19.138	3.900	23.038	7.678	32.460			40.138	63.176	213.188
2021				19.138	3.900	23.038	7.678	32.460			40.138	63.176	213.188
2022				19.138	3.900	23.038	7.678	32.460			40.138	63.176	213.188
2023				19.138	3.900	23.038	7.678	32.460			40.138	63.176	213.188
2024				19.138	3.900	23.038	7.678	32.460			40.138	63.176	213.188
2025				19.138	3.900	23.038	7.678	32.460			40.138	63.176	213.188
2026				19.138	3.900	23.038	7.678	32.460			40.138	63.176	213.188
2027	-197.515		-197.515	19.138	3.900	23.038	7.678	32.460			40.138	-134.339	213.188
			887.560			460.758					802.760	2,151.077	

Kamma Furrow - (Extension of Zanyokwe Pipeline) - Operation and Maintenance Costs

Construction Costs		(R x 1000)	Civil	M&E	Total
Existing Infrastructure					
Reservoir			5,500		5,500
Pipelines			1,764		1,764
Infield			1,237		1,237
Total of Existing Infrastructure			8,501		8,501
New Infrastructure					
Pipelines			5,825		5,825
Pipelines					
Reservoir					
Fencing			767		767
Infield			598		598
	construction subtotal		7,191		7,191
Design & Supervision fees - 16%			1,151		1,151
Total for new costs			8,341		8,341
Total for O&M costs			15,691		15,691
Maintenance Costs					
Annual O&M Costs			0.5%	4.0%	
Reservoir			1.0%		
			111.71		
Life of investment costs			40	10	
Residual Value (20 yrs)			20%		
Additional Unit Costs			50.9		
Catchment Management Agency R/h					
Water User Association R/ha		250	12,725		
Water levy (cents/cu.m)			0.67		
		sub-total	0.67		58.36
Energy Costs					
		Head (m)	Max Flow (l's)	Pump Eff'y	Motor Eff'y
				77%	85%
maximum kVA			load factor	0.9	
average number of hours a year					
average maximum demand (kW)					
Energy costs		(R x 1000)			
Personnel			Attendants	Labourer	Total
Pump Station / Dam / Pipeline					
Grade Salary/yr x Rx1000			48	24	
Costs	inc admin...	50%			
Vehicles		(R x 1000)	Heavy plant	Light Vehicles	Total
Total cost					
Maintenance at	10%				
Running costs	km/annum				
	km/l			10	
unit cost of fuel (diesel)	R / litre	4.50			
Cost per year					
Life (year)			10	6	

Annual Operation and Maintenance Costs

Year	**Investment costs** Civil R x1000	M&E Rx1000	Total Rx1000	**Maintenance costs** Civil Rx1000	M&E Rx1000	Total Rx1000	**Operational costs** Add.Costs Rx1000	Energy Rx1000	Personnel Rx1000	Vehicles Rx1000	Total Rx1000	Total Overall Costs	Water Supplied k m3
2005													
2006													
2007	8,341.181		8,341.181									8,341.181	
2008				111.709		111.709	15.695				15.695	127.404	443.357
2009				111.709		111.709	15.695				15.695	127.404	443.357
2010				111.709		111.709	15.695				15.695	127.404	443.357
2011				111.709		111.709	15.695				15.695	127.404	443.357
2012				111.709		111.709	15.695				15.695	127.404	443.357
2013				111.709		111.709	15.695				15.695	127.404	443.357
2014				111.709		111.709	15.695				15.695	127.404	443.357
2015				111.709		111.709	15.695				15.695	127.404	443.357
2016				111.709		111.709	15.695				15.695	127.404	443.357
2017				111.709		111.709	15.695				15.695	127.404	443.357
2018				111.709		111.709	15.695				15.695	127.404	443.357
2019				111.709		111.709	15.695				15.695	127.404	443.357
2020				111.709		111.709	15.695				15.695	127.404	443.357
2021				111.709		111.709	15.695				15.695	127.404	443.357
2022				111.709		111.709	15.695				15.695	127.404	443.357
2023				111.709		111.709	15.695				15.695	127.404	443.357
2024				111.709		111.709	15.695				15.695	127.404	443.357
2025				111.709		111.709	15.695				15.695	127.404	443.357
2026				111.709		111.709	15.695				15.695	127.404	443.357
2027	-1,668.236		-1,668.236	111.709		111.709	15.695				15.695	-1,540.832	443.357
			6,672.945			2,234.180					313.910	9,221.035	

MANTUSINI - Pumping from River - Operation and Maintenance Costs

Construction Costs	(R x 1000)	Civil	M&E	Total	
Pump Station			852	852	
Reservoir					
Pipelines		252		252	
Infield		968		968	
construction subtotal		1,220	852	2,071	
Design & Supervision fees - 16%		195	136	331	
Total for new costs		1,415	988	2,403	
Total for O&M		1,415	312		
Maintenance Costs					
Annual O&M Costs		0.5%	4.0%		
		7.07	12.47		
Life of investment costs		40	10		
Residual Value (20 yrs)		25%			
Additional Unit Costs		30			
Catchment Management Agency R/ha					
Water User Association R/ha					
Water levy (cents/cu.m)		0.67			
	sub-total	0.67		29.37	
Energy Costs					
	Head (m)	Max Flow (l's)	Pump Eff'y	Motor Eff'y	
	65	18	80%	85%	
maximum kVA		load factor	0.9	17	for 1
average number of hours a year				664	for 1
average maximum demand (kW)				15	for 1
Energy costs	(R x 1000)			63.90	for 3
Personnel		Attendants	Labourer	Total	
Dam					
Grade Salary/yr x Rx1000		48	24		
Costs inc admin...	50%				
Vehicles	(R x 1000)	Heavy plant	Light Vehicles	Total	
Total cost					
Maintenance at 10%					
Running costs km/annum					
km/l			10		
unit cost of fuel (diesel) R / litre	4.00				
Cost per year					
Life (year)		10	6		

Annual Operation and Maintenance Costs

Year	**Investment costs** Civil R x1000	M&E Rx1000	Total Rx1000	**Maintenance costs** Civil Rx1000	M&E Rx1000	Total Rx1000	**Operational costs** Add.Costs Rx1000	Energy Rx1000	Personnel Rx1000	Vehicles Rx1000	Total Rx1000	Total Overall Costs	Water Supplied M m3
2007	565.914		565.914									565.914	
2008	565.914	493.943	1,059.856									1,059.856	
2009	282.957	493.943	776.899									776.899	
2010				7.074	12.465	19.539	0.881	63.903			64.784	84.323	0.132
2011				7.074	12.465	19.539	0.881	63.903			64.784	84.323	0.132
2012				7.074	12.465	19.539	0.881	63.903			64.784	84.323	0.132
2013				7.074	12.465	19.539	0.881	63.903			64.784	84.323	0.132
2014				7.074	12.465	19.539	0.881	63.903			64.784	84.323	0.132
2015				7.074	12.465	19.539	0.881	63.903			64.784	84.323	0.132
2016				7.074	12.465	19.539	0.881	63.903			64.784	84.323	0.132
2017				7.074	12.465	19.539	0.881	63.903			64.784	84.323	0.132
2018				7.074	12.465	19.539	0.881	63.903			64.784	84.323	0.132
2019		987.885	987.885	7.074	12.465	19.539	0.881	63.903			64.784	1,072.208	0.132
2020				7.074	12.465	19.539	0.881	63.903			64.784	84.323	0.132
2021				7.074	12.465	19.539	0.881	63.903			64.784	84.323	0.132
2022				7.074	12.465	19.539	0.881	63.903			64.784	84.323	0.132
2023				7.074	12.465	19.539	0.881	63.903			64.784	84.323	0.132
2024				7.074	12.465	19.539	0.881	63.903			64.784	84.323	0.132
2025				7.074	12.465	19.539	0.881	63.903			64.784	84.323	0.132
2026				7.074	12.465	19.539	0.881	63.903			64.784	84.323	0.132
2027				7.074	12.465	19.539	0.881	63.903			64.784	84.323	0.132
2028				7.074	12.465	19.539	0.881	63.903			64.784	84.323	0.132
2029	-353.696		-353.696	7.074	12.465	19.539	0.881	63.903			64.784	-269.373	0.132
			3,036.858			390.778					1,295.678	8,150.950	

APPENDIX K

Smallholder LOS O&M Costs

KRUISFONTEIN - Operation and Maintenance Costs

Construction Costs		(R x 1000)	Civil	M&E	Total
Dams			41		41
Channels			32		32
Pipelines			316		316
Infield					
	construction subtotal		389		389
Design & Supervision fees - 16%			62		62
Total for new costs			451		451
Total for O&M			389		
Maintenance Costs					
Annual O&M Costs			0.5%	4.0%	
			2.3		
Life of investment costs			40	10	
Residual Value (20 yrs)			25%		
Additional Unit Costs			30		
Catchment Management Agency R/h					
Water User Association R/ha					
Water levy (cents/cu.m)			0.67		
		sub-total	0.67		20.67
Energy Costs					
		Head (m)	Max Flow (l's)	Pump Eff'y	Motor Eff'y
				80%	85%
maximum kVA			load factor	0.9	
average number of hours a year					1,045
average maximum demand (kW)					
Energy costs		(R x 1000)			
Personnel			Attendants	Labourer	Total
Dam					
Grade Salary/yr x Rx1000			48	24	
Costs	inc admin...	50%			
Vehicles		(R x 1000)	Heavy plant	Light Vehicles	Total
Total cost					
Maintenance at	10%				
Running costs	km/annum				
	km/l			10	
unit cost of fuel (diesel)	R / litre	4.00			
Cost per year					
Life (year)			10	6	

Annual Operation and Maintenance Costs

Year	**Investment costs**			**Maintenance costs**			**Operational costs**					Total	Water
	Civil	M&E	Total	Civil	M&E	Total	Add.Costs	Energy	Personnel	Vehicles	Total	Overall	Supplied
	R x1000	Rx1000	Rx1000	Rx1000	Rx1000	Rx1000	Rx1000	Rx1000	Rx1000	Rx1000	Rx1000	Costs	M m3
2007	180.462		180.462									180.462	
2008	180.462		180.462									180.462	
2009	90.231		90.231									90.231	
2010				2.256		2.256	0.620				0.620	2.876	0.093
2011				2.256		2.256	0.620				0.620	2.876	0.093
2012				2.256		2.256	0.620				0.620	2.876	0.093
2013				2.256		2.256	0.620				0.620	2.876	0.093
2014				2.256		2.256	0.620				0.620	2.876	0.093
2015				2.256		2.256	0.620				0.620	2.876	0.093
2016				2.256		2.256	0.620				0.620	2.876	0.093
2017				2.256		2.256	0.620				0.620	2.876	0.093
2018				2.256		2.256	0.620				0.620	2.876	0.093
2019				2.256		2.256	0.620				0.620	2.876	0.093
2020				2.256		2.256	0.620				0.620	2.876	0.093
2021				2.256		2.256	0.620				0.620	2.876	0.093
2022				2.256		2.256	0.620				0.620	2.876	0.093
2023				2.256		2.256	0.620				0.620	2.876	0.093
2024				2.256		2.256	0.620				0.620	2.876	0.093
2025				2.256		2.256	0.620				0.620	2.876	0.093
2026				2.256		2.256	0.620				0.620	2.876	0.093
2027				2.256		2.256	0.620				0.620	2.876	0.093
2028				2.256		2.256	0.620				0.620	2.876	0.093
2029	-112.789		-112.789	2.256		2.256	0.620				0.620	-109.913	0.093
			338.366			45.116					12.404	779.368	

TAMBOEKIESVLEI - Construction of Dam - Operation and Maintenance Costs

Construction Costs		(R x 1000)	Civil	M&E	Total
Dam			1,327		1,327
Outlet Works from Dam			38		38
Pipelines			893		893
Infield			761		761
	construction subtotal		3,019		3,019
Design & Supervision fees - 16%			483		483
Total for new costs			3,502		3,502
Total for O&M			3,019		
Maintenance Costs					
Annual O&M Costs			0.5%	4.0%	
Dam			0.25%		
			13.66		
Life of investment costs			40	10	
Residual Value (20 yrs)			25%		
Additional Unit Costs			29		
Catchment Management Agency R/ha					
Water User Association R/ha		250			
Water levy (cents/cu.m)			0.67		
		sub-total	0.67		44.296
Energy Costs					
		Head (m)	Max Flow (l's)	Pump Eff'y	Motor Eff'y
		30	27	80%	85%
maximum kVA			load factor	0.9	12
average number of hours a year					
average maximum demand (kW)					11
Energy costs		(R x 1000)			
Personnel			Attendants	Labourer	Total
Dam					
Grade Salary/yr x Rx1000			48	24	
Costs	inc admin...	50%			
Vehicles		(R x 1000)	Heavy plant	Light Vehicles	Total
Total cost					
Maintenance at	10%				
Running costs	km/annum				
	km/l			10	
unit cost of fuel (diesel)	R / litre	4.00			
Cost per year					
Life (year)			10	6	

Annual Operation and Maintenance Costs

Year	Investment costs			Maintenance costs			Operational costs					Total	Water
	Civil R x1000	M&E Rx1000	Total Rx1000	Civil Rx1000	M&E Rx1000	Total Rx1000	Add.Costs Rx1000	Energy Rx1000	Personnel Rx1000	Vehicles Rx1000	Total Rx1000	Overall Costs	Supplied M m3
2007	1,400.817		1,400.817									1,400.817	
2008	1,400.817		1,400.817									1,400.817	
2009	700.409		700.409									700.409	
2010				13.662		13.662	1.285				1.285	14.946	0.192
2011				13.662		13.662	1.285				1.285	14.946	0.192
2012				13.662		13.662	1.285				1.285	14.946	0.192
2013				13.662		13.662	1.285				1.285	14.946	0.192
2014				13.662		13.662	1.285				1.285	14.946	0.192
2015				13.662		13.662	1.285				1.285	14.946	0.192
2016				13.662		13.662	1.285				1.285	14.946	0.192
2017				13.662		13.662	1.285				1.285	14.946	0.192
2018				13.662		13.662	1.285				1.285	14.946	0.192
2019				13.662		13.662	1.285				1.285	14.946	0.192
2020				13.662		13.662	1.285				1.285	14.946	0.192
2021				13.662		13.662	1.285				1.285	14.946	0.192
2022				13.662		13.662	1.285				1.285	14.946	0.192
2023				13.662		13.662	1.285				1.285	14.946	0.192
2024				13.662		13.662	1.285				1.285	14.946	0.192
2025				13.662		13.662	1.285				1.285	14.946	0.192
2026				13.662		13.662	1.285				1.285	14.946	0.192
2027				13.662		13.662	1.285				1.285	14.946	0.192
2028				13.662		13.662	1.285				1.285	14.946	0.192
2029	-875.511		-875.511	13.662		13.662	1.285				1.285	-860.564	0.192
			2,626.533			273.236					25.692	5,825.229	

UMTATA - Phased serving 1/2 the area (Pumping from Umtata River) - Operation and Maintenance Costs

Construction Costs		(R x 1000)	Civil	M&E	Total
Diversion Works			156		156
Pump Station				1,639	1,639
Pipelines			2,426		2,426
Elevated Tank			1,279		1,279
Infield			2,465		2,465
	construction subtotal		6,326	1,639	7,965
Design & Supervision fees - 16%			1,012	262	1,274
Total for new costs			7,339	1,901	9,240
Maintenance Costs					
Annual O&M Costs			0.5%	4.0%	
			36.7	76.0	
Life of investment costs			40	10	
Residual Value (20 yrs)			20%		
Additional Unit Costs			85		
Catchment Management Agency R/h					
Water User Association R/ha		250	21,250		
Water levy (cents/cu.m)			0.67		
		sub-total	0.67		34.33
Energy Costs					
		Head (m)	Max Flow (l's)	Pump Eff'y	Motor Eff'y
		115	203	82%	85%
maximum kVA			load factor	0.9	367
average number of hours a year					596
average maximum demand (kW)					330
Energy costs		(R x 1000)			505.14
Personnel			Attendants	Labourer	Total
Pump Station / Pipeline					
Grade Salary/yr x Rx1000			48	24	
Costs	inc admin...	50%			
Vehicles		(R x 1000)	Heavy plant	Light Vehicles	Total
Total cost					
Maintenance at	10%				
Running costs	km/annum				
	km/l			10	
unit cost of fuel (diesel)	R / litre	4.00			
Cost per year					
Life (year)			10	6	

Annual Operation and Maintenance Costs

Year	Investment costs			Maintenance costs			Operational costs					Total	Water
	Civil R x1000	M&E Rx1000	Total Rx1000	Civil Rx1000	M&E Rx1000	Total Rx1000	Add.Costs Rx1000	Energy Rx1000	Personnel Rx1000	Vehicles Rx1000	Total Rx1000	Overall Costs	Supplied M m3
2007	2,935.493		2,935.493									2,935.493	
2008	2,935.493	950.541	3,886.034									3,886.034	
2009	1,467.746	950.541	2,418.288									2,418.288	
2010				36.694	76.043	112.737	24.168	505.141			529.309	642.046	0.44
2011				36.694	76.043	112.737	24.168	505.141			529.309	642.046	0.44
2012				36.694	76.043	112.737	24.168	505.141			529.309	642.046	0.44
2013				36.694	76.043	112.737	24.168	505.141			529.309	642.046	0.44
2014				36.694	76.043	112.737	24.168	505.141			529.309	642.046	0.44
2015				36.694	76.043	112.737	24.168	505.141			529.309	642.046	0.44
2016				36.694	76.043	112.737	24.168	505.141			529.309	642.046	0.44
2017				36.694	76.043	112.737	24.168	505.141			529.309	642.046	0.44
2018				36.694	76.043	112.737	24.168	505.141			529.309	642.046	0.44
2019		1,901.082	1,901.082	36.694	76.043	112.737	24.168	505.141			529.309	2,543.128	0.44
2020				36.694	76.043	112.737	24.168	505.141			529.309	642.046	0.44
2021				36.694	76.043	112.737	24.168	505.141			529.309	642.046	0.44
2022				36.694	76.043	112.737	24.168	505.141			529.309	642.046	0.44
2023				36.694	76.043	112.737	24.168	505.141			529.309	642.046	0.44
2024				36.694	76.043	112.737	24.168	505.141			529.309	642.046	0.44
2025				36.694	76.043	112.737	24.168	505.141			529.309	642.046	0.44
2026				36.694	76.043	112.737	24.168	505.141			529.309	642.046	0.44
2027				36.694	76.043	112.737	24.168	505.141			529.309	642.046	0.44
2028				36.694	76.043	112.737	24.168	505.141			529.309	642.046	0.44
2029				36.694	76.043	112.737	24.168	505.141			529.309	642.046	0.44
			11,140.897			2,254.739					10,586.176	23,981.812	

Wolf River - (Refurbishment of Existing Zanyokwe Section) - Operation and Maintenance Costs

Construction Costs	(R x 1000)	Civil	M&E	Total
Existing Infrastructure				
Reservoir		1,375		1,375
Pipelines		75		75
Infield		276		276
Total of Existing Infrastructure		1,450		1,450
Refurbishment				
Booster Pump Station		13	79	91
Fencing		406		406
Infield		417		417
construction subtotal		836	79	915
Design & Supervision fees - 16%		134	13	146
Total for new costs		969	79	1,061
Total for O&M costs		2,419	79	2,510
Maintenance Costs				
Annual O&M Costs		0.5%	4.0%	
Reservoir		1.0%		
		19.0	3.2	
Life of investment costs		40	10	
Residual Value (20 yrs)		20%		
Additional Unit Costs		25		
Catchment Management Agency R/h				
Water User Association R/ha	250	6,250		
Water levy (cents/cu.m)		0.67		
	sub-total	0.67		39.994
Energy Costs				
	Head (m)	Max Flow (l's)	Pump Eff'y	Motor Eff'y
	30	22	77%	85%
maximum kVA		load factor	0.9	11
average number of hours a year				
average maximum demand (kW)				10
Energy costs	(R x 1000)			24.53
Personnel		Attendants	Labourer	Total
Pump Station / Dam / Pipeline				
Grade Salary/yr x Rx1000		48	24	
Costs inc admin...	50%			
Vehicles	(R x 1000)	Heavy plant	Light Vehicles	Total
Total cost				
Maintenance at 10%				
Running costs km/annum				
km/l			10	
unit cost of fuel (diesel) R / litre	4.50			
Cost per year				
Life (year)		10	6	

Annual Operation and Maintenance Costs

Year	**Investment costs**			**Maintenance costs**			**Operational costs**					Total	Water
	Civil R x1000	M&E Rx1000	Total Rx1000	Civil Rx1000	M&E Rx1000	Total Rx1000	Add.Costs Rx1000	Energy Rx1000	Personnel Rx1000	Vehicles Rx1000	Total Rx1000	Overall Costs	Supplied k m3
2005													
2006													
2007	969.470		969.470									969.470	
2008				18.970	3.150	22.120	7.250	24.534			31.784	53.904	149.231
2009				18.970	3.150	22.120	7.250	24.534			31.784	53.904	149.231
2010				18.970	3.150	22.120	7.250	24.534			31.784	53.904	149.231
2011				18.970	3.150	22.120	7.250	24.534			31.784	53.904	149.231
2012				18.970	3.150	22.120	7.250	24.534			31.784	53.904	149.231
2013				18.970	3.150	22.120	7.250	24.534			31.784	53.904	149.231
2014				18.970	3.150	22.120	7.250	24.534			31.784	53.904	149.231
2015				18.970	3.150	22.120	7.250	24.534			31.784	53.904	149.231
2016				18.970	3.150	22.120	7.250	24.534			31.784	53.904	149.231
2017		78.750	78.750	18.970	3.150	22.120	7.250	24.534			31.784	132.654	149.231
2018				18.970	3.150	22.120	7.250	24.534			31.784	53.904	149.231
2019				18.970	3.150	22.120	7.250	24.534			31.784	53.904	149.231
2020				18.970	3.150	22.120	7.250	24.534			31.784	53.904	149.231
2021				18.970	3.150	22.120	7.250	24.534			31.784	53.904	149.231
2022				18.970	3.150	22.120	7.250	24.534			31.784	53.904	149.231
2023				18.970	3.150	22.120	7.250	24.534			31.784	53.904	149.231
2024				18.970	3.150	22.120	7.250	24.534			31.784	53.904	149.231
2025				18.970	3.150	22.120	7.250	24.534			31.784	53.904	149.231
2026				18.970	3.150	22.120	7.250	24.534			31.784	53.904	149.231
2027	-193.894		-193.894	18.970	3.150	22.120	7.250	24.534			31.784	-139.990	149.231
			854.326			442.410					635.679	1,932.415	

Kamma Furrow - (Extension of Zanyokwe Pipeline) - Operation and Maintenance Costs

Construction Costs	(R x 1000)	Civil	M&E	Total
Existing Infrastructure				
Reservoir		5,500		5,500
Pipelines		1,764		1,764
Infield		1,171		1,171
Total of Existing Infrastructure		8,434		8,434
New Infrastructure				
Pipelines		4,641		4,641
Pipelines				
Reservoir				
Fencing		767		767
Infield		598		598
construction subtotal		6,006		6,006
Design & Supervision fees - 16%		961		961
Total for new costs		6,968		6,968
Total for O&M costs		14,441		14,441
Maintenance Costs				
Annual O&M Costs		0.5%	4.0%	
Reservoir		1.0%		
		104.5		
Life of investment costs		40	10	
Residual Value (20 yrs)		20%		
Additional Unit Costs		50.9		
Catchment Management Agency R/h				
Water User Association R/ha	250	12,725		
Water levy (cents/cu.m)		0.67		
sub-total		0.67		40.852
Energy Costs				
	Head (m)	Max Flow (l's)	Pump Eff'y	Motor Eff'y
			77%	85%
maximum kVA		load factor	0.9	
average number of hours a year				
average maximum demand (kW)				
Energy costs	(R x 1000)			
Personnel		Attendants	Labourer	Total
Pump Station / Dam / Pipeline				
Grade Salary/yr x Rx1000		48	24	
Costs inc admin...	50%			
Vehicles	(R x 1000)	Heavy plant	Light Vehicles	Total
Total cost				
Maintenance at	10%			
Running costs km/annum				
km/l			10	
unit cost of fuel (diesel) R / litre	4.50			
Cost per year				
Life (year)		10	6	

Annual Operation and Maintenance Costs

Year	**Investment costs** Civil R x1000	M&E Rx1000	Total Rx1000	**Maintenance costs** Civil Rx1000	M&E Rx1000	Total Rx1000	**Operational costs** Add.Costs Rx1000	Energy Rx1000	Personnel Rx1000	Vehicles Rx1000	Total Rx1000	Total Overall Costs	Water Supplied k m3
2005													
2006													
2007	6,967.515		6,967.515									6,967.515	
2008				104.510		104.510	14.804				14.804	119.314	310.350
2009				104.510		104.510	14.804				14.804	119.314	310.350
2010				104.510		104.510	14.804				14.804	119.314	310.350
2011				104.510		104.510	14.804				14.804	119.314	310.350
2012				104.510		104.510	14.804				14.804	119.314	310.350
2013				104.510		104.510	14.804				14.804	119.314	310.350
2014				104.510		104.510	14.804				14.804	119.314	310.350
2015				104.510		104.510	14.804				14.804	119.314	310.350
2016				104.510		104.510	14.804				14.804	119.314	310.350
2017				104.510		104.510	14.804				14.804	119.314	310.350
2018				104.510		104.510	14.804				14.804	119.314	310.350
2019				104.510		104.510	14.804				14.804	119.314	310.350
2020				104.510		104.510	14.804				14.804	119.314	310.350
2021				104.510		104.510	14.804				14.804	119.314	310.350
2022				104.510		104.510	14.804				14.804	119.314	310.350
2023				104.510		104.510	14.804				14.804	119.314	310.350
2024				104.510		104.510	14.804				14.804	119.314	310.350
2025				104.510		104.510	14.804				14.804	119.314	310.350
2026				104.510		104.510	14.804				14.804	119.314	310.350
2027	-1,393.503		-1,393.503	104.510		104.510	14.804				14.804	-1,274.189	310.350
			5,574.012			2,090.193					296.087	7,960.291	

MANTUSINI - Pumping from River - Operation and Maintenance Costs

Construction Costs		(R x 1000)	Civil	M&E	Total	
Pump Station				878	878	
Reservoir						
Pipelines			139		139	
Infield			855		855	
	construction subtotal		994	878	1,871	
Design & Supervision fees - 16%			159	140	299	
Total for new costs			1,153	1,018	2,171	
Total for O&M			994	315		
Maintenance Costs						
Annual O&M Costs			0.5%	4.0%		
			5.8	12.6		
Life of investment costs			40	10		
Residual Value (20 yrs)			25%			
Additional Unit Costs			30			
Catchment Management Agency R/h						
Water User Association R/ha						
Water levy (cents/cu.m)			0.67			
		sub-total	0.67		20.562	
Energy Costs						
		Head (m)	Max Flow (l's)	Pump Eff'y	Motor Eff'y	
		65	13	80%	85%	
maximum kVA			load factor	0.9	12	for 1
average number of hours a year					664	for 1
average maximum demand (kW)					11	for 1
Energy costs		(R x 1000)			47.29	for 3
Personnel			Attendants	Labourer	Total	
Dam						
Grade Salary/yr x Rx1000			48	24		
Costs	inc admin...	50%				
Vehicles		(R x 1000)	Heavy plant	Light Vehicles	Total	
Total cost						
Maintenance at	10%					
Running costs	km/annum					
	km/l			10		
unit cost of fuel (diesel)	R / litre	4.00				
Cost per year						
Life (year)			10	6		

Annual Operation and Maintenance Costs

Year	**Investment costs**			**Maintenance costs**			**Operational costs**					Total	Water
	Civil	M&E	Total	Civil	M&E	Total	Add.Costs	Energy	Personnel	Vehicles	Total	Overall	Supplied
	R x1000	Rx1000	Rx1000	Rx1000	Rx1000	Rx1000	Rx1000	Rx1000	Rx1000	Rx1000	Rx1000	Costs	M m3
2007	461.067		461.067									461.067	
2008	461.067	508.950	970.017									970.017	
2009	230.533	508.950	739.483									739.483	
2010				5.763	12.600	18.363	0.617	47.295			47.912	66.275	0.092
2011				5.763	12.600	18.363	0.617	47.295			47.912	66.275	0.092
2012				5.763	12.600	18.363	0.617	47.295			47.912	66.275	0.092
2013				5.763	12.600	18.363	0.617	47.295			47.912	66.275	0.092
2014				5.763	12.600	18.363	0.617	47.295			47.912	66.275	0.092
2015				5.763	12.600	18.363	0.617	47.295			47.912	66.275	0.092
2016				5.763	12.600	18.363	0.617	47.295			47.912	66.275	0.092
2017				5.763	12.600	18.363	0.617	47.295			47.912	66.275	0.092
2018				5.763	12.600	18.363	0.617	47.295			47.912	66.275	0.092
2019		1,017.900	1,017.900	5.763	12.600	18.363	0.617	47.295			47.912	1,084.175	0.092
2020				5.763	12.600	18.363	0.617	47.295			47.912	66.275	0.092
2021				5.763	12.600	18.363	0.617	47.295			47.912	66.275	0.092
2022				5.763	12.600	18.363	0.617	47.295			47.912	66.275	0.092
2023				5.763	12.600	18.363	0.617	47.295			47.912	66.275	0.092
2024				5.763	12.600	18.363	0.617	47.295			47.912	66.275	0.092
2025				5.763	12.600	18.363	0.617	47.295			47.912	66.275	0.092
2026				5.763	12.600	18.363	0.617	47.295			47.912	66.275	0.092
2027				5.763	12.600	18.363	0.617	47.295			47.912	66.275	0.092
2028				5.763	12.600	18.363	0.617	47.295			47.912	66.275	0.092
2029	-288.167		-288.167	5.763	12.600		0.617	47.295			47.912	-221.892	0.092
			2,900.300			367.267					958.231	7,493.364	

APPENDIX L

Commercial Under-utilised LOS O&M Costs

KRUISFONTEIN - Operation and Maintenance Costs

Construction Costs		(R x 1000)	Civil	M&E	Total	
Dams			41		41	
Channels			32		32	
Pipelines			480		480	
Infield						
	construction subtotal		553		553	
Design & Supervision fees - 16%			88		88	
Total for new costs			642		642	
Total for O&M			553			
Maintenance Costs						
Annual O&M Costs			0.5%	4.0%		
			3.2			
Life of investment costs			40	10		
Residual Value (20 yrs)			25%			
Additional Unit Costs			30			
Catchment Management Agency R/ha						
Water User Association R/ha						
Water levy (cents/cu.m)			0.67			
		sub-total	0.67		20.673	
Energy Costs						
		Head (m)	Max Flow (l's)	Pump Eff'y	Motor Eff'y	
				80%	85%	
maximum kVA			load factor	0.9		for 1
average number of hours a year					1,045	for 1
average maximum demand (kW)						for 1
Energy costs		(R x 1000)				for 3
Personnel			Attendants	Labourer	Total	
Dam						
Grade Salary/yr x Rx1000			48	24		
Costs	inc admin...	50%				
Vehicles		(R x 1000)	Heavy plant	Light Vehicles	Total	
Total cost						
Maintenance at	10%					
Running costs	km/annum					
	km/l			10		
unit cost of fuel (diesel)	R / litre	4.00				
Cost per year						
Life (year)			10	6		

Annual Operation and Maintenance Costs

Year	Investment costs			Maintenance costs			Operational costs					Total	Water
	Civil R x1000	M&E Rx1000	Total Rx1000	Civil Rx1000	M&E Rx1000	Total Rx1000	Add.Costs Rx1000	Energy Rx1000	Personnel Rx1000	Vehicles Rx1000	Total Rx1000	Overall Costs	Supplied M m3
2007	256.622		256.622									256.622	
2008	256.622		256.622									256.622	
2009	128.311		128.311									128.311	
2010				3.208		3.208	0.620				0.620	3.828	0.093
2011				3.208		3.208	0.620				0.620	3.828	0.093
2012				3.208		3.208	0.620				0.620	3.828	0.093
2013				3.208		3.208	0.620				0.620	3.828	0.093
2014				3.208		3.208	0.620				0.620	3.828	0.093
2015				3.208		3.208	0.620				0.620	3.828	0.093
2016				3.208		3.208	0.620				0.620	3.828	0.093
2017				3.208		3.208	0.620				0.620	3.828	0.093
2018				3.208		3.208	0.620				0.620	3.828	0.093
2019				3.208		3.208	0.620				0.620	3.828	0.093
2020				3.208		3.208	0.620				0.620	3.828	0.093
2021				3.208		3.208	0.620				0.620	3.828	0.093
2022				3.208		3.208	0.620				0.620	3.828	0.093
2023				3.208		3.208	0.620				0.620	3.828	0.093
2024				3.208		3.208	0.620				0.620	3.828	0.093
2025				3.208		3.208	0.620				0.620	3.828	0.093
2026				3.208		3.208	0.620				0.620	3.828	0.093
2027				3.208		3.208	0.620				0.620	3.828	0.093
2028				3.208		3.208	0.620				0.620	3.828	0.093
2029	-160.389		-160.389	3.208		3.208	0.620				0.620	-156.561	0.093
			481.167			64.156					12.404	1,103.049	

TAMBOEKIESVLEI - Construction of Dam - Operation and Maintenance Costs

Construction Costs	(R x 1000)	Civil	M&E	Total
Dam		2,323		2,323
Outlet Works from Dam		38		38
Pipelines		1,426		1,426
Infield		761		761
construction subtotal		4,548		4,548
Design & Supervision fees - 16%		728		728
Total for new costs		5,275		5,275
Total for O&M		4,548		
Maintenance Costs				
Annual O&M Costs		0.5%	4.0%	
Dam		0.25%		
		19.64		
Life of investment costs		40	10	
Residual Value (20 yrs)		25%		
Additional Unit Costs		29		
Catchment Management Agency R/h				
Water User Association R/ha	250			
Water levy (cents/cu.m)		0.67		
sub-total		0.67		44.296
Energy Costs				
	Head (m)	Max Flow (l's)	Pump Eff'y	Motor Eff'y
	30	28	80%	85%
maximum kVA		load factor	0.9	12
average number of hours a year				
average maximum demand (kW)				11
Energy costs	(R x 1000)			
Personnel		Attendants	Labourer	Total
Dam				
Grade Salary/yr x Rx1000		48	24	
Costs inc admin...	50%			
Vehicles	(R x 1000)	Heavy plant	Light Vehicles	Total
Total cost				
Maintenance at	10%			
Running costs km/annum				
km/l			10	
unit cost of fuel (diesel) R / litre	4.00			
Cost per year				
Life (year)		10	6	

Annual Operation and Maintenance Costs

Year	**Investment costs**			**Maintenance costs**			**Operational costs**					Total	Water
	Civil R x1000	M&E Rx1000	Total Rx1000	Civil Rx1000	M&E Rx1000	Total Rx1000	Add.Costs Rx1000	Energy Rx1000	Personnel Rx1000	Vehicles Rx1000	Total Rx1000	Overall Costs	Supplied M m3
2007	2,110.109		2,110.109									2,110.109	
2008	2,110.109		2,110.109									2,110.109	
2009	1,055.055		1,055.055									1,055.055	
2010				19.639		19.639	1.285				1.285	20.924	0.192
2011				19.639		19.639	1.285				1.285	20.924	0.192
2012				19.639		19.639	1.285				1.285	20.924	0.192
2013				19.639		19.639	1.285				1.285	20.924	0.192
2014				19.639		19.639	1.285				1.285	20.924	0.192
2015				19.639		19.639	1.285				1.285	20.924	0.192
2016				19.639		19.639	1.285				1.285	20.924	0.192
2017				19.639		19.639	1.285				1.285	20.924	0.192
2018				19.639		19.639	1.285				1.285	20.924	0.192
2019				19.639		19.639	1.285				1.285	20.924	0.192
2020				19.639		19.639	1.285				1.285	20.924	0.192
2021				19.639		19.639	1.285				1.285	20.924	0.192
2022				19.639		19.639	1.285				1.285	20.924	0.192
2023				19.639		19.639	1.285				1.285	20.924	0.192
2024				19.639		19.639	1.285				1.285	20.924	0.192
2025				19.639		19.639	1.285				1.285	20.924	0.192
2026				19.639		19.639	1.285				1.285	20.924	0.192
2027				19.639		19.639	1.285				1.285	20.924	0.192
2028				19.639		19.639	1.285				1.285	20.924	0.192
2029	-1,318.818		-1,318.818	19.639		19.639	1.285				1.285	-1,297.894	0.192
			3,956.455			392.788					25.692	8,724.177	

UMTATA - Phased serving 1/2 the area (Pumping from Umtata River) - Operation and Maintenance Costs

Construction Costs		(R x 1000)	Civil	M&E	Total
Diversion Works			156		156
Pump Station				2,233	2,233
Pipelines			2,711		2,711
Elevated Tank			1,445		1,445
Infield			2,752		2,752
	construction subtotal		7,064	2,233	9,297
Design & Supervision fees - 16%			1,130	357	1,488
Total for new costs			8,194	2,591	10,785
Maintenance Costs					
Annual O&M Costs			0.5%	4.0%	
			41.0	103.6	
Life of investment costs			40	10	
Residual Value (20 yrs)			20%		
Additional Unit Costs			85		
Catchment Management Agency R/h					
Water User Association R/ha		250	21,250		
Water levy (cents/cu.m)			0.67		
		sub-total	0.67		34.333
Energy Costs					
		Head (m)	Max Flow (l's)	Pump Eff'y	Motor Eff'y
		115	276	82%	85%
maximum kVA			load factor	0.9	499
average number of hours a year					945
average maximum demand (kW)					449
Energy costs		(R x 1000)			715.97
Personnel			Attendants	Labourer	Total
Pump Station / Pipeline					
Grade Salary/yr x Rx1000			48	24	
Costs	inc admin...	50%			
Vehicles		(R x 1000)	Heavy plant	Light Vehicles	Total
Total cost					
Maintenance at	10%				
Running costs	km/annum				
	km/l			10	
unit cost of fuel (diesel)	R / litre	4.00			
Cost per year					
Life (year)			10	6	

Annual Operation and Maintenance Costs

Year	**Investment costs**			**Maintenance costs**			**Operational costs**					Total	Water
	Civil R x1000	M&E Rx1000	Total Rx1000	Civil Rx1000	M&E Rx1000	Total Rx1000	Add.Costs Rx1000	Energy Rx1000	Personnel Rx1000	Vehicles Rx1000	Total Rx1000	Overall Costs	Supplied M m3
2007	3,277.551		3,277.551									3,277.551	
2008	3,277.551	1,295.354	4,572.905									4,572.905	
2009	1,638.775	1,295.354	2,934.130									2,934.130	
2010				40.969	103.628	144.598	24.168	715.966			740.134	884.732	0.44
2011				40.969	103.628	144.598	24.168	715.966			740.134	884.732	0.44
2012				40.969	103.628	144.598	24.168	715.966			740.134	884.732	0.44
2013				40.969	103.628	144.598	24.168	715.966			740.134	884.732	0.44
2014				40.969	103.628	144.598	24.168	715.966			740.134	884.732	0.44
2015				40.969	103.628	144.598	24.168	715.966			740.134	884.732	0.44
2016				40.969	103.628	144.598	24.168	715.966			740.134	884.732	0.44
2017				40.969	103.628	144.598	24.168	715.966			740.134	884.732	0.44
2018				40.969	103.628	144.598	24.168	715.966			740.134	884.732	0.44
2019		2,590.709	2,590.709	40.969	103.628	144.598	24.168	715.966			740.134	3,475.440	0.44
2020				40.969	103.628	144.598	24.168	715.966			740.134	884.732	0.44
2021				40.969	103.628	144.598	24.168	715.966			740.134	884.732	0.44
2022				40.969	103.628	144.598	24.168	715.966			740.134	884.732	0.44
2023				40.969	103.628	144.598	24.168	715.966			740.134	884.732	0.44
2024				40.969	103.628	144.598	24.168	715.966			740.134	884.732	0.44
2025				40.969	103.628	144.598	24.168	715.966			740.134	884.732	0.44
2026				40.969	103.628	144.598	24.168	715.966			740.134	884.732	0.44
2027				40.969	103.628	144.598	24.168	715.966			740.134	884.732	0.44
2028				40.969	103.628	144.598	24.168	715.966			740.134	884.732	0.44
2029				40.969	103.628	144.598	24.168	715.966			740.134	884.732	0.44
			13,375.294			2,891.955					14,802.678	31,069.926	

Wolf River - (Refurbishment of Existing Zanyokwe Section) - Operation and Maintenance Costs

Construction Costs		(R x 1000)	Civil	M&E	Total
Existing Infrastructure					
Reservoir			1,375		1,375
Pipelines			90		90
Infield			276		276
Total of Existing Infrastructure			1,465		1,465
Refurbishment					
Booster Pump Station			13	98	110
Fencing			406		406
Infield			417		417
	construction subtotal		836	98	933
Design & Supervision fees - 16%			134	16	149
Total for new costs			969	98	1,083
Total for O&M costs			2,434	98	2,548
Maintenance Costs					
Annual O&M Costs			0.5%	4.0%	
Reservoir			1.0%		
			19.0	3.9	
Life of investment costs			40	10	
Residual Value (20 yrs)			20%		
Additional Unit Costs			25		
Catchment Management Agency R/h					
Water User Association R/ha		250	6,250		
Water levy (cents/cu.m)			0.67		
		sub-total	0.67		39.99
Energy Costs					
		Head (m)	Max Flow (l's)	Pump Eff'y	Motor Eff'y
		30	30	77%	85%
maximum kVA			load factor	0.9	15
average number of hours a year					
average maximum demand (kW)					13
Energy costs		(R x 1000)			30.42
Personnel			Attendants	Labourer	Total
Pump Station / Dam / Pipeline					
Grade Salary/yr x Rx1000			48	24	
Costs	inc admin...	50%			
Vehicles		(R x 1000)	Heavy plant	Light Vehicles	Total
Total cost					
Maintenance at	10%				
Running costs	km/annum				
	km/l			10	
unit cost of fuel (diesel)	R / litre	4.50			
Cost per year					
Life (year)			10	6	
2007					

Annual Operation and Maintenance Costs

Year	**Investment costs** Civil R x1000	M&E Rx1000	Total Rx1000	**Maintenance costs** Civil Rx1000	M&E Rx1000	Total Rx1000	**Operational costs** Add.Costs Rx1000	Energy Rx1000	Personnel Rx1000	Vehicles Rx1000	Total Rx1000	Total Overall Costs	Water Supplied k m3
2005													
2006													
2007	969.470		969.470									969.470	
2008				19.047	3.900	22.947	7.250	30.419			37.669	60.616	149.231
2009				19.047	3.900	22.947	7.250	30.419			37.669	60.616	149.231
2010				19.047	3.900	22.947	7.250	30.419			37.669	60.616	149.231
2011				19.047	3.900	22.947	7.250	30.419			37.669	60.616	149.231
2012				19.047	3.900	22.947	7.250	30.419			37.669	60.616	149.231
2013				19.047	3.900	22.947	7.250	30.419			37.669	60.616	149.231
2014				19.047	3.900	22.947	7.250	30.419			37.669	60.616	149.231
2015				19.047	3.900	22.947	7.250	30.419			37.669	60.616	149.231
2016				19.047	3.900	22.947	7.250	30.419			37.669	60.616	149.231
2017		97.500	97.500	19.047	3.900	22.947	7.250	30.419			37.669	158.116	149.231
2018				19.047	3.900	22.947	7.250	30.419			37.669	60.616	149.231
2019				19.047	3.900	22.947	7.250	30.419			37.669	60.616	149.231
2020				19.047	3.900	22.947	7.250	30.419			37.669	60.616	149.231
2021				19.047	3.900	22.947	7.250	30.419			37.669	60.616	149.231
2022				19.047	3.900	22.947	7.250	30.419			37.669	60.616	149.231
2023				19.047	3.900	22.947	7.250	30.419			37.669	60.616	149.231
2024				19.047	3.900	22.947	7.250	30.419			37.669	60.616	149.231
2025				19.047	3.900	22.947	7.250	30.419			37.669	60.616	149.231
2026				19.047	3.900	22.947	7.250	30.419			37.669	60.616	149.231
2027	-193.894		-193.894	19.047	3.900	22.947	7.250	30.419			37.669	-133.278	149.231
			873.076			458.947					753.379	2,085.402	

Kamma Furrow - (Extension of Zanyokwe Pipeline) - Operation and Maintenance Costs

Construction Costs	(R x 1000)	Civil	M&E	Total
Existing Infrastructure				
Reservoir		5,500		5,500
Pipelines		1,764		1,764
Infield		1,171		1,171
Total of Existing Infrastructure		8,434		8,434
New Infrastructure				
Pipelines		5,825		5,825
Pipelines				
Reservoir				
Fencing		767		767
Infield		598		598
construction subtotal		7,191		7,191
Design & Supervision fees - 16%		1,151		1,151
Total for new costs		8,341		8,341
Total for O&M costs		15,625		15,625
Maintenance Costs				
Annual O&M Costs		0.5%	4.0%	
Reservoir		1.0%		
		111.4		
Life of investment costs		40	10	
Residual Value (20 yrs)		20%		
Additional Unit Costs		50.9		
Catchment Management Agency R/ha				
Water User Association R/ha	250	12,725		
Water levy (cents/cu.m)		0.67		
	sub-total	0.67		40.852
Energy Costs				
	Head (m)	Max Flow (l's)	Pump Eff'y	Motor Eff'y
			77%	85%
maximum kVA		load factor	0.9	
average number of hours a year				
average maximum demand (kW)				
Energy costs	(R x 1000)			
Personnel		Attendants	Labourer	Total
Pump Station / Dam / Pipeline				
Grade Salary/yr x Rx1000		48	24	
Costs inc admin...	50%			
Vehicles	(R x 1000)	Heavy plant	Light Vehicles	Total
Total cost				
Maintenance at 10%				
Running costs km/annum				
km/l			10	
unit cost of fuel (diesel) R / litre	4.50			
2007				
Life (year)		10.000	6.000	

Annual Operation and Maintenance Costs

Year	**Investment costs**			**Maintenance costs**			**Operational costs**					Total	Water
	Civil R x1000	M&E Rx1000	Total Rx1000	Civil Rx1000	M&E Rx1000	Total Rx1000	Add.Costs Rx1000	Energy Rx1000	Personnel Rx1000	Vehicles Rx1000	Total Rx1000	Overall Costs	Supplied k m3
2005													
2006													
2007	8,341.181		8,341.181									8,341.181	
2008				111.378		111.378	14.804				14.804	126.182	310.350
2009				111.378		111.378	14.804				14.804	126.182	310.350
2010				111.378		111.378	14.804				14.804	126.182	310.350
2011				111.378		111.378	14.804				14.804	126.182	310.350
2012				111.378		111.378	14.804				14.804	126.182	310.350
2013				111.378		111.378	14.804				14.804	126.182	310.350
2014				111.378		111.378	14.804				14.804	126.182	310.350
2015				111.378		111.378	14.804				14.804	126.182	310.350
2016				111.378		111.378	14.804				14.804	126.182	310.350
2017				111.378		111.378	14.804				14.804	126.182	310.350
2018				111.378		111.378	14.804				14.804	126.182	310.350
2019				111.378		111.378	14.804				14.804	126.182	310.350
2020				111.378		111.378	14.804				14.804	126.182	310.350
2021				111.378		111.378	14.804				14.804	126.182	310.350
2022				111.378		111.378	14.804				14.804	126.182	310.350
2023				111.378		111.378	14.804				14.804	126.182	310.350
2024				111.378		111.378	14.804				14.804	126.182	310.350
2025				111.378		111.378	14.804				14.804	126.182	310.350
2026				111.378		111.378	14.804				14.804	126.182	310.350
2027	-1,668.236		-1,668.236	111.378		111.378	14.804				14.804	-1,542.054	310.350
			6,672.945			2,227.559					296.087	9,196.591	

MANTUSINI - Pumping from River - Operation and Maintenance Costs

Construction Costs		(R x 1000)	Civil	M&E	Total	
Pump Station				852	852	
Reservoir						
Pipelines			252		252	
Infield			968		968	
	construction subtotal		1,220	852	2,071	
Design & Supervision fees - 16%			195	136	331	
Total for new costs			1,415	988	2,403	
Total for O&M			1,220	312		
Maintenance Costs						
Annual O&M Costs			0.5%	4.0%		
			7.1	12.5		
Life of investment costs			40	10		
Residual Value (20 yrs)			25%			
Additional Unit Costs			30			
Catchment Management Agency R/h						
Water User Association R/ha						
Water levy (cents/cu.m)			0.67			
		sub-total	0.67		20.562	
Energy Costs						
		Head (m)	Max Flow (l's)	Pump Eff'y	Motor Eff'y	
		65	18	80%	85%	
maximum kVA			load factor	0.9	17	for 1
average number of hours a year					465	for 1
average maximum demand (kW)					15	for 1
Energy costs		(R x 1000)			52.39	for 3
Personnel			Attendants	Labourer	Total	
Dam						
Grade Salary/yr x Rx1000			48	24		
Costs	inc admin...	50%				
Vehicles		(R x 1000)	Heavy plant	Light Vehicles	Total	
Total cost						
Maintenance at	10%					
Running costs	km/annum					
	km/l			10		
unit cost of fuel (diesel)	R / litre	4.00				
Cost per year						
Life (year)			10	6		

Annual Operation and Maintenance Costs

Year	**Investment costs**			**Maintenance costs**			**Operational costs**					Total	Water
	Civil R x1000	M&E Rx1000	Total Rx1000	Civil Rx1000	M&E Rx1000	Total Rx1000	Add.Costs Rx1000	Energy Rx1000	Personnel Rx1000	Vehicles Rx1000	Total Rx1000	Overall Costs	Supplied M m3
2007	565.914		565.914									565.914	
2008	565.914	493.943	1,059.856									1,059.856	
2009	282.957	493.943	776.899									776.899	
2010				7.074	12.465	19.539	0.617	52.390			53.007	72.545	0.092
2011				7.074	12.465	19.539	0.617	52.390			53.007	72.545	0.092
2012				7.074	12.465	19.539	0.617	52.390			53.007	72.545	0.092
2013				7.074	12.465	19.539	0.617	52.390			53.007	72.545	0.092
2014				7.074	12.465	19.539	0.617	52.390			53.007	72.545	0.092
2015				7.074	12.465	19.539	0.617	52.390			53.007	72.545	0.092
2016				7.074	12.465	19.539	0.617	52.390			53.007	72.545	0.092
2017				7.074	12.465	19.539	0.617	52.390			53.007	72.545	0.092
2018				7.074	12.465	19.539	0.617	52.390			53.007	72.545	0.092
2019		987.885	987.885	7.074	12.465	19.539	0.617	52.390			53.007	1,060.430	0.092
2020				7.074	12.465	19.539	0.617	52.390			53.007	72.545	0.092
2021				7.074	12.465	19.539	0.617	52.390			53.007	72.545	0.092
2022				7.074	12.465	19.539	0.617	52.390			53.007	72.545	0.092
2023				7.074	12.465	19.539	0.617	52.390			53.007	72.545	0.092
2024				7.074	12.465	19.539	0.617	52.390			53.007	72.545	0.092
2025				7.074	12.465	19.539	0.617	52.390			53.007	72.545	0.092
2026				7.074	12.465	19.539	0.617	52.390			53.007	72.545	0.092
2027				7.074	12.465	19.539	0.617	52.390			53.007	72.545	0.092
2028				7.074	12.465	19.539	0.617	52.390			53.007	72.545	0.092
2029	-353.696		-353.696	7.074	12.465	19.539	0.617	52.390			53.007	-281.151	0.092
			3,036.858			390.778					1,060.130	7,915.403	

APPENDIX M
Commercial LOS Gross Margins

Kruisfontein - Gross Margins

Scheme Assumptions		Gross Margins per Hectare for a Variety of Irrigated Crops								**TOTAL**
Area (Ha)	20									
		Crops	**Green Mielies**	**Potato**	**Tomato**	**Carrot**	**Maize**	**Dry Beans**	**Cabbage**	
		Area planted (Ha)	1	1	1	1	1	1	1	7
PROJECT NET RETURNS		**EXPENSES (R)**								
		Land Preparation	1997	1997	1997	1997	1997	1997	1997	13979
Commercial	R 573,184.00	Inputs	3993	16638	25555	5537	4392	4046	12778	72939
		Labour	666	532	13537	2662	932	666	5990	24985
		Irrigation Power Cost (Var)	0	0	0	0	0	0	0	0
		Harvesting & packaging	1331	3328	38067	14641	666	333	7986	66352
		Total Production Costs (TPC)	**7987**	**22495**	**79156**	**24837**	**7987**	**7042**	**28751**	**178255**
		INCOME								
		Units	Cobs	10 kg Bag	5 kg Box	Tons	kg	kg	14 kg Bag	
		Yield (YLD)	12500	3000	10000	35	9000	2500	3000	
		Average selling price (ASP)	1.5	25.3	18.6	2236.1	1.4	5.3	19.4	
		Gross income (YLDxASP)	18750	75900	186000	78263.5	12600	13250	58200	442963.5
		Gross Margin (GI-TPC)	**10763**	**53405**	**106844**	**53426.5**	**4613**	**6208**	**29449**	264708.5
	Management Factors	**Average Gross Margin for Mix of Crops on a one hectare unit**								
		Area planted (Ha)	0.4	0.05	0.05	0.1	0.2	0.2	0.3	1
	Commercial	Gross income	7500	3795	9300	7826.35	2520	2650	17460	51051.35
	Farmer 100%	**Gross Margin**	**4305.2**	**2670.25**	**5342.2**	**5342.65**	**922.6**	**1241.6**	**8834.7**	**28659.2**

Tamboekiesvlei - Gross Margin

Scheme Assumptions		Gross Margins per Hectare for a Variety of Irrigated Crops								TOTAL
Area (Ha)	35									
		Crops	**Green Mielies**	**Potato**	**Tomato**	**Carrot**	**Maize**	**Dry Beans**	**Cabbage**	
		Area planted (Ha)	1	1	1	1	1	1	1	7
PROJECT NET RETURNS		**EXPENSES (R)**								
		Land Preparation	1997	1997	1997	1997	1997	1997	1997	13979
Commercial	R 1,003,072.00	Inputs	3993	16638	25555	5537	4392	4046	12778	72939
		Labour	666	532	13537	2662	932	666	5990	24985
		Irrigation Power Cost (Var)	0	0	0	0	0	0	0	0
		Harvesting & packaging	1331	3328	38067	14641	666	333	7986	66352
		Total Production Costs (TPC)	**7987**	**22495**	**79156**	**24837**	**7987**	**7042**	**28751**	**178255**
		INCOME								
		Units	Cobs	10 kg Bag	5 kg Box	Tons	kg	kg	14 kg Bag	
		Yield (YLD)	12500	3000	10000	35	9000	2500	3000	
		Average selling price (ASP)	1.5	25.3	18.6	2236.1	1.4	5.3	19.4	
		Gross income (YLDxASP)	18750	75900	186000	78263.5	12600	13250	58200	442963.5
		Gross Margin (GI-TPC)	**10763**	**53405**	**106844**	**53426.5**	**4613**	**6208**	**29449**	264708.5
	Management Factors	**Average Gross Margin for Mix of Crops on a one hectare unit**								
		Area planted (Ha)	0.4	0.05	0.05	0.1	0.2	0.2	0.3	1
	Commercial	Gross income	7500	3795	9300	7826.35	2520	2650	17460	51051.35
	Farmer 100%	**Gross Margin**	**4305.2**	**2670.25**	**5342.2**	**5342.65**	**922.6**	**1241.6**	**8834.7**	**28659.2**

Ncambedlana - Gross Margins

Scheme Assumptions		Gross Margins per Hectare for a Variety of Irrigated Crops								TOTAL
Area (Ha)	85									
		Crops	**Green Mielies**	**Potato**	**Tomato**	**Carrot**	**Maize**	**Dry Beans**	**Cabbage**	
		Area planted (Ha)	1	1	1	1	1	1	1	7
PROJECT NET RETURNS		**EXPENSES (R)**								
		Land Preparation	1997	1997	1997	1997	1997	1997	1997	13979
Commercial	R 1,608,642.00	Inputs	3993	16638	25555	5537	4392	4046	12778	72939
		Labour	666	532	13537	2662	932	666	5990	24985
		Irrigation Power Cost (Var)	9734	9734	9734	9734	9734	9734	0	58404
		Harvesting & packaging	1331	3328	38067	14641	666	333	7986	66352
		Total Production Costs (TPC)	**17721**	**32229**	**88890**	**34571**	**17721**	**16776**	**28751**	**236659**
		INCOME								
		Units	Cobs	10 kg Bag	5 kg Box	Tons	kg	kg	14 kg Bag	
		Yield (YLD)	12500	3000	10000	35	9000	2500	3000	
		Average selling price (ASP)	1.5	25.3	18.6	2236.1	1.4	5.3	19.4	
		Gross income (YLDxASP)	18750	75900	186000	78263.5	12600	13250	58200	442963.5
		Gross Margin (GI-TPC)	**1029**	**43671**	**97110**	**43692.5**	**-5121**	**-3526**	**29449**	206304.5
	Management Factors	**Average Gross Margin for Mix of Crops on a one hectare unit**								
		Area planted (Ha)	0.4	0.05	0.05	0.1	0.2	0.2	0.3	1
	Commercial	Gross income	7500	3795	9300	7826.35	2520	2650	17460	51051.35
	Farmer 100%	**Gross Margin**	**411.6**	**2183.55**	**4855.5**	**4369.25**	**-1024.2**	**-705.2**	**8834.7**	**18925.2**

Wolf River - Gross Margin

Scheme Assumptions		Gross Margins per Hectare for a Variety of Irrigated Crops								**TOTAL**
Area (Ha)	25									
		Crops	**Green Mielies**	**Potato**	**Tomato**	**Carrot**	**Maize**	**Dry Beans**	**Cabbage**	
		Area planted (Ha)	1	1	1	1	1	1	1	7
PROJECT NET RETURNS		**EXPENSES (R)**								
		Land Preparation	1997	1997	1997	1997	1997	1997	1997	13979
Commercial	R 684,030.00	Inputs	3993	16638	25555	5537	4392	4046	12778	72939
		Labour	666	532	13537	2662	932	666	5990	24985
		Irrigation Power Cost (Var)	1298	1298	1298	1298	1298	1298	0	7788
		Harvesting & packaging	1331	3328	38067	14641	666	333	7986	66352
		Total Production Costs (TPC)	**9285**	**23793**	**80454**	**26135**	**9285**	**8340**	**28751**	**186043**
		INCOME								
		Units	Cobs	10 kg Bag	5 kg Box	Tons	kg	kg	14 kg Bag	
		Yield (YLD)	12500	3000	10000	35	9000	2500	3000	
		Average selling price (ASP)	1.5	25.3	18.6	2236.1	1.4	5.3	19.4	
		Gross income (YLDxASP)	18750	75900	186000	78263.5	12600	13250	58200	442963.5
		Gross Margin (GI-TPC)	**9465**	**52107**	**105546**	**52128.5**	**3315**	**4910**	**29449**	256920.5
	Management Factors	**Average Gross Margin for Mix of Crops on a one hectare unit**								
		Area planted (Ha)	0.4	0.05	0.05	0.1	0.2	0.2	0.3	1
	Commercial	Gross income	7500	3795	9300	7826.35	2520	2650	17460	51051.35
	Farmer 100%	**Gross Margin**	**3786**	**2605.35**	**5277.3**	**5212.85**	**663**	**982**	**8834.7**	**27361.2**

Kama Furrow - Gross Margins

Scheme Assumptions										TOTAL
Area (Ha)	50	Gross Margins per Hectare for a Variety of Irrigated Crops								
		Crops	**Green Mielies**	**Potato**	**Tomato**	**Carrot**	**Maize**	**Dry Beans**	**Cabbage**	
		Area planted (Ha)	1	1	1	1	1	1	1	7
PROJECT NET RETURNS		**EXPENSES (R)**								
		Land Preparation	1997	1997	1997	1997	1997	1997	1997	13979
Commercial	R 1,432,960.00	Inputs	3993	16638	25555	5537	4392	4046	12778	72939
		Labour	666	532	13537	2662	932	666	5990	24985
		Irrigation Power Cost (Var)	0	0	0	0	0	0	0	0
		Harvesting & packaging	1331	3328	38067	14641	666	333	7986	66352
		Total Production Costs (TPC)	**7987**	**22495**	**79156**	**24837**	**7987**	**7042**	**28751**	**178255**
		INCOME								
		Units	Cobs	10 kg Bag	5 kg Box	Tons	kg	kg	14 kg Bag	
		Yield (YLD)	12500	3000	10000	35	9000	2500	3000	
		Average selling price (ASP)	1.5	25.3	18.6	2236.1	1.4	5.3	19.4	
		Gross income (YLDxASP)	18750	75900	186000	78263.5	12600	13250	58200	442963.5
		Gross Margin (GI-TPC)	**10763**	**53405**	**106844**	**53426.5**	**4613**	**6208**	**29449**	264708.5
	Management Factors	**Average Gross Margin for Mix of Crops on a one hectare unit**								
		Area planted (Ha)	0.4	0.05	0.05	0.1	0.2	0.2	0.3	1
	Commercial	Gross income	7500	3795	9300	7826.35	2520	2650	17460	51051.35
	Farmer 100%	**Gross Margin**	**4305.2**	**2670.25**	**5342.2**	**5342.65**	**922.6**	**1241.6**	**8834.7**	**28659.2**

Mantusini - Gross Margins

Scheme Assumptions		Gross Margins per Hectare for a Variety of Irrigated Crops								**TOTAL**
Area (Ha)	30									
		Crops	**Green Mielies**	**Potato**	**Tomato**	**Carrot**	**Maize**	**Dry Beans**	**Cabbage**	
		Area planted (Ha)	1	1	1	1	1	1	1	7
PROJECT NET RETURNS		**EXPENSES (R)**								
		Land Preparation	1997	1997	1997	1997	1997	1997	1997	13979
Commercial	R 795,876.00	Inputs	3993	16638	25555	5537	4392	4046	12778	72939
		Labour	666	532	13537	2662	932	666	5990	24985
		Irrigation Power Cost (Var)	2130	2130	2130	2130	2130	2130	0	12780
		Harvesting & packaging	1331	3328	38067	14641	666	333	7986	66352
		Total Production Costs (TPC)	**10117**	**24625**	**81286**	**26967**	**10117**	**9172**	**28751**	**191035**
		INCOME								
		Units	Cobs	10 kg Bag	5 kg Box	Tons	kg	kg	14 kg Bag	
		Yield (YLD)	12500	3000	10000	35	9000	2500	3000	
		Average selling price (ASP)	1.5	25.3	18.6	2236.1	1.4	5.3	19.4	
		Gross income (YLDxASP)	18750	75900	186000	78263.5	12600	13250	58200	442963.5
		Gross Margin (GI-TPC)	**8633**	**51275**	**104714**	**51296.5**	**2483**	**4078**	**29449**	251928.5
	Management Factors	**Average Gross Margin for Mix of Crops on a one hectare unit**								
		Area planted (Ha)	0.4	0.05	0.05	0.1	0.2	0.2	0.3	1
	Commercial	Gross income	7500	3795	9300	7826.35	2520	2650	17460	51051.35
	Farmer 100%	**Gross Margin**	**3453.2**	**2563.75**	**5235.7**	**5129.65**	**496.6**	**815.6**	**8834.7**	**26529.2**

APPENDIX N
Smallholder LOS Gross Margins

Kruisfontein - Gross Margins

Scheme Assumptions		Gross Margins per Hectare for a Variety of Irrigated Crops								**TOTAL**
Area (Ha)	20									
		Crops	**Green Mielies**	**Potato**	**Tomato**	**Carrot**	**Maize**	**Dry Beans**	**Cabbage**	
		Area planted (Ha)	1	1	1	1	1	1	1	7
PROJECT NET RETURNS		**EXPENSES (R)**								
		Land Preparation	1997	1997	1997	1997	1997	1997	1997	13979
Small-holder	R 343,910.40	Inputs	3993	16638	25555	5537	4392	4046	12778	72939
		Labour	666	532	13537	2662	932	666	5990	24985
		Irrigation Power Cost (Var)	0	0	0	0	0	0	0	0
		Harvesting & packaging	1331	3328	38067	14641	666	333	7986	66352
		Total Production Costs (TPC)	**7987**	**22495**	**79156**	**24837**	**7987**	**7042**	**28751**	**178255**
		INCOME								
		Units	Cobs	10 kg Bag	5 kg Box	Tons	kg	kg	14 kg Bag	
		Yield (YLD)	12500	3000	10000	35	9000	2500	3000	
		Average selling price (ASP)	1.5	25.3	18.6	2236.1	1.4	5.3	19.4	
		Gross income (YLDxASP)	18750	75900	186000	78263.5	12600	13250	58200	442963.5
		Gross Margin (GI-TPC)	**10763**	**53405**	**106844**	**53426.5**	**4613**	**6208**	**29449**	264708.5
	Management Factors	**Average Gross Margin for Mix of Crops on a one hectare unit**								
		Area planted (Ha)	0.4	0.05	0.05	0.1	0.2	0.2	0.3	1
	Small-holder	Gross income	4500	2277	5580	4695.81	1512	1590	10476	30630.81
	Farmer 60%	**Gross Margin**	**2583.12**	**1602.15**	**3205.32**	**3205.59**	**553.56**	**744.96**	**5300.82**	**17195.52**

Tamboekiesvlei - Gross Margin

Scheme Assumptions		Gross Margins per Hectare for a Variety of Irrigated Crops								TOTAL
Area (Ha)	35									
		Crops	**Green Mielies**	**Potato**	**Tomato**	**Carrot**	**Maize**	**Dry Beans**	**Cabbage**	
		Area planted (Ha)	1	1	1	1	1	1	1	7
PROJECT NET RETURNS		**EXPENSES (R)**								
		Land Preparation	1997	1997	1997	1997	1997	1997	1997	13979
Small-holder	R 601,843.20	Inputs	3993	16638	25555	5537	4392	4046	12778	72939
		Labour	666	532	13537	2662	932	666	5990	24985
		Irrigation Power Cost (Var)	0	0	0	0	0	0	0	0
		Harvesting & packaging	1331	3328	38067	14641	666	333	7986	66352
		Total Production Costs (TPC)	**7987**	**22495**	**79156**	**24837**	**7987**	**7042**	**28751**	**178255**
		INCOME								
		Units	Cobs	10 kg Bag	5 kg Box	Tons	kg	kg	14 kg Bag	
		Yield (YLD)	12500	3000	10000	35	9000	2500	3000	
		Average selling price (ASP)	1.5	25.3	18.6	2236.1	1.4	5.3	19.4	
		Gross income (YLDxASP)	18750	75900	186000	78263.5	12600	13250	58200	442963.5
		Gross Margin (GI-TPC)	**10763**	**53405**	**106844**	**53426.5**	**4613**	**6208**	**29449**	264708.5
	Management Factors	**Average Gross Margin for Mix of Crops on a one hectare unit**								
		Area planted (Ha)	0.4	0.05	0.05	0.1	0.2	0.2	0.3	1
	Small-holder	Gross income	4500	2277	5580	4695.81	1512	1590	10476	30630.81
	Farmer 60%	**Gross Margin**	**2583.12**	**1602.15**	**3205.32**	**3205.59**	**553.56**	**744.96**	**5300.82**	**17195.52**

Ncambedlana - Gross Margins

Scheme Assumptions		Gross Margins per Hectare for a Variety of Irrigated Crops								TOTAL
Area (Ha)	85									
		Crops	**Green Mielies**	**Potato**	**Tomato**	**Carrot**	**Maize**	**Dry Beans**	**Cabbage**	
		Area planted (Ha)	1	1	1	1	1	1	1	7
PROJECT NET RETURNS		**EXPENSES (R)**								
		Land Preparation	1997	1997	1997	1997	1997	1997	1997	13979
Small-holder	R 1,158,526.20	Inputs	3993	16638	25555	5537	4392	4046	12778	72939
		Labour	666	532	13537	2662	932	666	5990	24985
		Irrigation Power Cost (Var)	5943	5943	5943	5943	5943	5943	0	35658
		Harvesting & packaging	1331	3328	38067	14641	666	333	7986	66352
		Total Production Costs (TPC)	**13930**	**28438**	**85099**	**30780**	**13930**	**12985**	**28751**	**213913**
		INCOME								
		Units	Cobs	10 kg Bag	5 kg Box	Tons	kg	kg	14 kg Bag	
		Yield (YLD)	12500	3000	10000	35	9000	2500	3000	
		Average selling price (ASP)	1.5	25.3	18.6	2236.1	1.4	5.3	19.4	
		Gross income (YLDxASP)	18750	75900	186000	78263.5	12600	13250	58200	442963.5
		Gross Margin (GI-TPC)	**4820**	**47462**	**100901**	**47483.5**	**-1330**	**265**	**29449**	229050.5
	Management Factors	**Average Gross Margin for Mix of Crops on a one hectare unit**								
		Area planted (Ha)	0.4	0.05	0.05	0.1	0.2	0.2	0.3	1
	Small-holder	Gross income	4500	2277	5580	4695.81	1512	1590	10476	30630.81
	Farmer 60%	**Gross Margin**	**1156.8**	**1423.86**	**3027.03**	**2849.01**	**-159.6**	**31.8**	**5300.82**	**13629.72**

Wolf River - Gross Margin

Scheme Assumptions		Gross Margins per Hectare for a Variety of Irrigated Crops								**TOTAL**
Area (Ha)	25									
		Crops	**Green Mielies**	**Potato**	**Tomato**	**Carrot**	**Maize**	**Dry Beans**	**Cabbage**	
		Area planted (Ha)	1	1	1	1	1	1	1	7
PROJECT NET RETURNS		**EXPENSES (R)**								
		Land Preparation	1997	1997	1997	1997	1997	1997	1997	13979
Small-holder	R 415,173.00	Inputs	3993	16638	25555	5537	4392	4046	12778	72939
		Labour	666	532	13537	2662	932	666	5990	24985
		Irrigation Power Cost (Var)	981	981	981	981	981	981	0	5886
		Harvesting & packaging	1331	3328	38067	14641	666	333	7986	66352
		Total Production Costs (TPC)	**8968**	**23476**	**80137**	**25818**	**8968**	**8023**	**28751**	**184141**
		INCOME								
		Units	Cobs	10 kg Bag	5 kg Box	Tons	kg	kg	14 kg Bag	
		Yield (YLD)	12500	3000	10000	35	9000	2500	3000	
		Average selling price (ASP)	1.5	25.3	18.6	2236.1	1.4	5.3	19.4	
		Gross income (YLDxASP)	18750	75900	186000	78263.5	12600	13250	58200	442963.5
		Gross Margin (GI-TPC)	**9782**	**52424**	**105863**	**52445.5**	**3632**	**5227**	**29449**	258822.5
	Management Factors	**Average Gross Margin for Mix of Crops on a one hectare unit**								
		Area planted (Ha)	0.4	0.05	0.05	0.1	0.2	0.2	0.3	1
	Small-holder	Gross income	4500	2277	5580	4695.81	1512	1590	10476	30630.81
	Farmer 60%	**Gross Margin**	**2347.68**	**1572.72**	**3175.89**	**3146.73**	**435.84**	**627.24**	**5300.82**	**16606.92**

Kama Furrow - Gross Margins

Scheme Assumptions		Gross Margins per Hectare for a Variety of Irrigated Crops								TOTAL
Area (Ha)	50									
		Crops	**Green Mielies**	**Potato**	**Tomato**	**Carrot**	**Maize**	**Dry Beans**	**Cabbage**	
		Area planted (Ha)	1	1	1	1	1	1	1	7
PROJECT NET RETURNS		**EXPENSES (R)**								
		Land Preparation	1997	1997	1997	1997	1997	1997	1997	13979
Small-holder	R 859,776.00	Inputs	3993	16638	25555	5537	4392	4046	12778	72939
		Labour	666	532	13537	2662	932	666	5990	24985
		Irrigation Power Cost (Var)	0	0	0	0	0	0	0	0
		Harvesting & packaging	1331	3328	38067	14641	666	333	7986	66352
		Total Production Costs (TPC)	**7987**	**22495**	**79156**	**24837**	**7987**	**7042**	**28751**	**178255**
		INCOME								
		Units	Cobs	10 kg Bag	5 kg Box	Tons	kg	kg	14 kg Bag	
		Yield (YLD)	12500	3000	10000	35	9000	2500	3000	
		Average selling price (ASP)	1.5	25.3	18.6	2236.1	1.4	5.3	19.4	
		Gross income (YLDxASP)	18750	75900	186000	78263.5	12600	13250	58200	442963.5
		Gross Margin (GI-TPC)	**10763**	**53405**	**106844**	**53426.5**	**4613**	**6208**	**29449**	264708.5
	Management Factors	**Average Gross Margin for Mix of Crops on a one hectare unit**								
		Area planted (Ha)	0.4	0.05	0.05	0.1	0.2	0.2	0.3	1
	Small-holder	Gross income	4500	2277	5580	4695.81	1512	1590	10476	30630.81
	Farmer 60%	**Gross Margin**	**2583.12**	**1602.15**	**3205.32**	**3205.59**	**553.56**	**744.96**	**5300.82**	**17195.52**

Mantusini - Gross Margins

Scheme Assumptions		Gross Margins per Hectare for a Variety of Irrigated Crops								**TOTAL**
Area (Ha)	30									
		Crops	**Green Mielies**	**Potato**	**Tomato**	**Carrot**	**Maize**	**Dry Beans**	**Cabbage**	
		Area planted (Ha)	1	1	1	1	1	1	1	7
PROJECT NET RETURNS		**EXPENSES (R)**								
		Land Preparation	1997	1997	1997	1997	1997	1997	1997	13979
Small-holder	R 487,497.60	Inputs	3993	16638	25555	5537	4392	4046	12778	72939
		Labour	666	532	13537	2662	932	666	5990	24985
		Irrigation Power Cost (Var)	1576	1576	1576	1576	1576	1576	0	9456
		Harvesting & packaging	1331	3328	38067	14641	666	333	7986	66352
		Total Production Costs (TPC)	**9563**	**24071**	**80732**	**26413**	**9563**	**8618**	**28751**	**187711**
		INCOME								
		Units	Cobs	10 kg Bag	5 kg Box	Tons	kg	kg	14 kg Bag	
		Yield (YLD)	12500	3000	10000	35	9000	2500	3000	
		Average selling price (ASP)	1.5	25.3	18.6	2236.1	1.4	5.3	19.4	
		Gross income (YLDxASP)	18750	75900	186000	78263.5	12600	13250	58200	442963.5
		Gross Margin (GI-TPC)	**9187**	**51829**	**105268**	**51850.5**	**3037**	**4632**	**29449**	255252.5
	Management Factors	**Average Gross Margin for Mix of Crops on a one hectare unit**								
		Area planted (Ha)	0.4	0.05	0.05	0.1	0.2	0.2	0.3	1
	Small-holder	Gross income	4500	2277	5580	4695.81	1512	1590	10476	30630.81
	Farmer 60%	**Gross Margin**	**2204.88**	**1554.87**	**3158.04**	**3111.03**	**364.44**	**555.84**	**5300.82**	**16249.92**

APPENDIX O
Commercial Under-utilised Gross Margins

Kruisfontein - Gross Margins

Scheme Assumptions		Gross Margins per Hectare for a Variety of Irrigated Crops								**TOTAL**
Area (Ha)	20									
		Crops	**Green Mielies**	**Potato**	**Tomato**	**Carrot**	**Maize**	**Dry Beans**	**Cabbage**	
		Area planted (Ha)	1	1	1	1	1	1	1	7
PROJECT NET RETURNS		**EXPENSES (R)**								
		Land Preparation	1997	1997	1997	1997	1997	1997	1997	13979
Commercial under utilised	R 343,910.40	Inputs	3993	16638	25555	5537	4392	4046	12778	72939
		Labour	666	532	13537	2662	932	666	5990	24985
		Irrigation Power Cost (Var)	0	0	0	0	0	0	0	0
		Harvesting & packaging	1331	3328	38067	14641	666	333	7986	66352
		Total Production Costs (TPC)	**7987**	**22495**	**79156**	**24837**	**7987**	**7042**	**28751**	**178255**
		INCOME								
		Units	Cobs	10 kg Bag	5 kg Box	Tons	kg	kg	14 kg Bag	
		Yield (YLD)	12500	3000	10000	35	9000	2500	3000	
		Average selling price (ASP)	1.5	25.3	18.6	2236.1	1.4	5.3	19.4	
		Gross income (YLDxASP)	18750	75900	186000	78263.5	12600	13250	58200	442963.5
		Gross Margin (GI-TPC)	**10763**	**53405**	**106844**	**53426.5**	**4613**	**6208**	**29449**	264708.5
	Management Factors	**Average Gross Margin for Mix of Crops on a one hectare unit**								
		Area planted (Ha)	0.4	0.05	0.05	0.1	0.2	0.2	0.3	1
	Commercial under utilised Farmer 60%	Gross income	4500	2277	5580	4695.81	1512	1590	10476	30630.81
		Gross Margin	**2583.12**	**1602.15**	**3205.32**	**3205.59**	**553.56**	**744.96**	**5300.82**	**17195.52**

Tamboekiesvlei - Gross Margin

Scheme Assumptions		Gross Margins per Hectare for a Variety of Irrigated Crops								**TOTAL**
Area (Ha)	35									
		Crops	**Green Mielies**	**Potato**	**Tomato**	**Carrot**	**Maize**	**Dry Beans**	**Cabbage**	
		Area planted (Ha)	1	1	1	1	1	1	1	7
PROJECT NET RETURNS		**EXPENSES (R)**								
		Land Preparation	1997	1997	1997	1997	1997	1997	1997	13979
Commercial under utilised	R 601,843.20	Inputs	3993	16638	25555	5537	4392	4046	12778	72939
		Labour	666	532	13537	2662	932	666	5990	24985
		Irrigation Power Cost (Var)	0	0	0	0	0	0	0	0
		Harvesting & packaging	1331	3328	38067	14641	666	333	7986	66352
		Total Production Costs (TPC)	**7987**	**22495**	**79156**	**24837**	**7987**	**7042**	**28751**	**178255**
		INCOME								
		Units	Cobs	10 kg Bag	5 kg Box	Tons	kg	kg	14 kg Bag	
		Yield (YLD)	12500	3000	10000	35	9000	2500	3000	
		Average selling price (ASP)	1.5	25.3	18.6	2236.1	1.4	5.3	19.4	
		Gross income (YLDxASP)	18750	75900	186000	78263.5	12600	13250	58200	442963.5
		Gross Margin (GI-TPC)	**10763**	**53405**	**106844**	**53426.5**	**4613**	**6208**	**29449**	264708.5
	Management Factors	**Average Gross Margin for Mix of Crops on a one hectare unit**								
		Area planted (Ha)	0.4	0.05	0.05	0.1	0.2	0.2	0.3	1
	Commercial under utilised Farmer 60%	Gross income	4500	2277	5580	4695.81	1512	1590	10476	30630.81
		Gross Margin	**2583.12**	**1602.15**	**3205.32**	**3205.59**	**553.56**	**744.96**	**5300.82**	**17195.52**

Ncambedlana - Gross Margins

Scheme Assumptions		Gross Margins per Hectare for a Variety of Irrigated Crops								**TOTAL**
Area (Ha)	85									
		Crops	**Green Mielies**	**Potato**	**Tomato**	**Carrot**	**Maize**	**Dry Beans**	**Cabbage**	
		Area planted (Ha)	1	1	1	1	1	1	1	7
PROJECT NET RETURNS		**EXPENSES (R)**								
		Land Preparation	1997	1997	1997	1997	1997	1997	1997	13979
Commercial under utilised	R 1,032,046.20	Inputs	3993	16638	25555	5537	4392	4046	12778	72939
		Labour	666	532	13537	2662	932	666	5990	24985
		Irrigation Power Cost (Var)	8423	8423	8423	8423	8423	8423	0	50538
		Harvesting & packaging	1331	3328	38067	14641	666	333	7986	66352
		Total Production Costs (TPC)	**16410**	**30918**	**87579**	**33260**	**16410**	**15465**	**28751**	**228793**
		INCOME								
		Units	Cobs	10 kg Bag	5 kg Box	Tons	kg	kg	14 kg Bag	
		Yield (YLD)	12500	3000	10000	35	9000	2500	3000	
		Average selling price (ASP)	1.5	25.3	18.6	2236.1	1.4	5.3	19.4	
		Gross income (YLDxASP)	18750	75900	186000	78263.5	12600	13250	58200	442963.5
		Gross Margin (GI-TPC)	**2340**	**44982**	**98421**	**45003.5**	**-3810**	**-2215**	**29449**	214170.5
	Management Factors	**Average Gross Margin for Mix of Crops on a one hectare unit**								
		Area planted (Ha)	0.4	0.05	0.05	0.1	0.2	0.2	0.3	1
	Commercial under utilised Farmer 60%	Gross income	4500	2277	5580	4695.81	1512	1590	10476	30630.81
		Gross Margin	**561.6**	**1349.46**	**2952.63**	**2700.21**	**-457.2**	**-265.8**	**5300.82**	**12141.72**

Wolf River - Gross Margin

Scheme Assumptions		Gross Margins per Hectare for a Variety of Irrigated Crops								**TOTAL**
Area (Ha)	25									
		Crops	**Green Mielies**	**Potato**	**Tomato**	**Carrot**	**Maize**	**Dry Beans**	**Cabbage**	
		Area planted (Ha)	1	1	1	1	1	1	1	7
PROJECT NET RETURNS		**EXPENSES (R)**								
		Land Preparation	1997	1997	1997	1997	1997	1997	1997	13979
Commercial under utilised	R 411,633.00	Inputs	3993	16638	25555	5537	4392	4046	12778	72939
		Labour	666	532	13537	2662	932	666	5990	24985
		Irrigation Power Cost (Var)	1217	1217	1217	1217	1217	1217	0	7302
		Harvesting & packaging	1331	3328	38067	14641	666	333	7986	66352
		Total Production Costs (TPC)	**9204**	**23712**	**80373**	**26054**	**9204**	**8259**	**28751**	**185557**
		INCOME								
		Units	Cobs	10 kg Bag	5 kg Box	Tons	kg	kg	14 kg Bag	
		Yield (YLD)	12500	3000	10000	35	9000	2500	3000	
		Average selling price (ASP)	1.5	25.3	18.6	2236.1	1.4	5.3	19.4	
		Gross income (YLDxASP)	18750	75900	186000	78263.5	12600	13250	58200	442963.5
		Gross Margin (GI-TPC)	**9546**	**52188**	**105627**	**52209.5**	**3396**	**4991**	**29449**	257406.5
	Management Factors	**Average Gross Margin for Mix of Crops on a one hectare unit**								
		Area planted (Ha)	0.4	0.05	0.05	0.1	0.2	0.2	0.3	1
	Commercial under utilised Farmer 60%	Gross income	4500	2277	5580	4695.81	1512	1590	10476	30630.81
		Gross Margin	**2291.04**	**1565.64**	**3168.81**	**3132.57**	**407.52**	**598.92**	**5300.82**	**16465.32**

Kama Furrow - Gross Margins

Scheme Assumptions		Gross Margins per Hectare for a Variety of Irrigated Crops								TOTAL
Area (Ha)	50									
		Crops	**Green Mielies**	**Potato**	**Tomato**	**Carrot**	**Maize**	**Dry Beans**	**Cabbage**	
		Area planted (Ha)	1	1	1	1	1	1	1	7
PROJECT NET RETURNS		**EXPENSES (R)**								
		Land Preparation	1997	1997	1997	1997	1997	1997	1997	13979
Commercial under utilised	R 859,776.00	Inputs	3993	16638	25555	5537	4392	4046	12778	72939
		Labour	666	532	13537	2662	932	666	5990	24985
		Irrigation Power Cost (Var)	0	0	0	0	0	0	0	0
		Harvesting & packaging	1331	3328	38067	14641	666	333	7986	66352
		Total Production Costs (TPC)	**7987**	**22495**	**79156**	**24837**	**7987**	**7042**	**28751**	**178255**
		INCOME								
		Units	Cobs	10 kg Bag	5 kg Box	Tons	kg	kg	14 kg Bag	
		Yield (YLD)	12500	3000	10000	35	9000	2500	3000	
		Average selling price (ASP)	1.5	25.3	18.6	2236.1	1.4	5.3	19.4	
		Gross income (YLDxASP)	18750	75900	186000	78263.5	12600	13250	58200	442963.5
		Gross Margin (GI-TPC)	**10763**	**53405**	**106844**	**53426.5**	**4613**	**6208**	**29449**	264708.5
	Management Factors	**Average Gross Margin for Mix of Crops on a one hectare unit**								
		Area planted (Ha)	0.4	0.05	0.05	0.1	0.2	0.2	0.3	1
	Commercial under utilised	Gross income	4500	2277	5580	4695.81	1512	1590	10476	30630.81
	Farmer 60%	**Gross Margin**	**2583.12**	**1602.15**	**3205.32**	**3205.59**	**553.56**	**744.96**	**5300.82**	**17195.52**

Mantusini - Gross Margins

Scheme Assumptions		Gross Margins per Hectare for a Variety of Irrigated Crops								TOTAL
Area (Ha)	30									
		Crops	**Green Mielies**	**Potato**	**Tomato**	**Carrot**	**Maize**	**Dry Beans**	**Cabbage**	
		Area planted (Ha)	1	1	1	1	1	1	1	7
PROJECT NET RETURNS		**EXPENSES (R)**								
		Land Preparation	1997	1997	1997	1997	1997	1997	1997	13979
Commercial under utilised	R 484,437.60	Inputs	3993	16638	25555	5537	4392	4046	12778	72939
		Labour	666	532	13537	2662	932	666	5990	24985
		Irrigation Power Cost (Var)	1746	1746	1746	1746	1746	1746	0	10476
		Harvesting & packaging	1331	3328	38067	14641	666	333	7986	66352
		Total Production Costs (TPC)	**9733**	**24241**	**80902**	**26583**	**9733**	**8788**	**28751**	**188731**
		INCOME								
		Units	Cobs	10 kg Bag	5 kg Box	Tons	kg	kg	14 kg Bag	
		Yield (YLD)	12500	3000	10000	35	9000	2500	3000	
		Average selling price (ASP)	1.5	25.3	18.6	2236.1	1.4	5.3	19.4	
		Gross income (YLDxASP)	18750	75900	186000	78263.5	12600	13250	58200	442963.5
		Gross Margin (GI-TPC)	**9017**	**51659**	**105098**	**51680.5**	**2867**	**4462**	**29449**	254232.5
	Management Factors	**Average Gross Margin for Mix of Crops on a one hectare unit**								
		Area planted (Ha)	0.4	0.05	0.05	0.1	0.2	0.2	0.3	1
	Commercial under utilised Farmer 60%	Gross income	4500	2277	5580	4695.81	1512	1590	10476	30630.81
		Gross Margin	**2164.08**	**1549.77**	**3152.94**	**3100.83**	**344.04**	**535.44**	**5300.82**	**16147.92**

APPENDIX P
Commercial LOS Financial Evaluation

Financial Analysis

Scheme Kruisfontein
LOS Commercial

Item	Rate	Year 1	2	3	4	5	6	7	8	9	10
Area under irrigation		20	20	20	20	20	20	20	20	20	20
Expenses											
Production cost	R 22,392.15	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00
Machines, equipment & tools etc											
O&M of infrastructure		R 4,093.78	R 4,093.78	R 4,093.78	R 4,093.78	R 4,093.78	R 4,093.78	R 4,093.78	R 4,093.78	R 4,093.78	R 4,093.78
Infrastructure loan repayments	8%	R 118,624.57	R 118,624.57	R 118,624.57	R 118,624.57	R 118,624.57					
Working capital repayments	12%	R 506,169.19	R 506,169.19	R 379,626.90	R 253,084.60	R 253,084.60	R 253,084.60	R 253,084.60	R 253,084.60	R 253,084.60	R 253,084.60
Sub-total		R 1,076,730.54	R 1,076,730.54	R 950,188.24	R 823,645.95	R 823,645.95	R 705,021.38	R 705,021.38	R 705,021.38	R 705,021.38	R 705,021.38
Income											
Gross income	R 51,051.35	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00
Subsidy		R 200,000.00									
Working capital loan		R 451,936.78	R 451,936.78	R 338,952.59	R 225,968.39	R 225,968.39	R 225,968.39	R 225,968.39	R 225,968.39	R 225,968.39	R 225,968.39
Sub-total		R 1,672,963.78	R 1,472,963.78	R 1,359,979.59	R 1,246,995.39	R 1,246,995.39	R 1,246,995.39	R 1,246,995.39	R 1,246,995.39	R 1,246,995.39	R 1,246,995.39
Net income		R 596,233.24	R 396,233.24	R 409,791.34	R 423,349.44	R 423,349.44	R 541,974.01	R 541,974.01	R 541,974.01	R 541,974.01	R 541,974.01
Tax	15%	R 89,434.99	R 59,434.99	R 61,468.70	R 63,502.42	R 63,502.42	R 81,296.10	R 81,296.10	R 81,296.10	R 81,296.10	R 81,296.10
Net benefit of project		R 506,798.25	R 336,798.25	R 348,322.64	R 359,847.03	R 359,847.03	R 460,677.91	R 460,677.91	R 460,677.91	R 460,677.91	R 460,677.91
Return on investment		75.23%	50.00%	51.71%	53.42%	53.42%	68.39%	68.39%	68.39%	68.39%	68.39%
Average total net income per hectare		R 25,339.91	R 16,839.91	R 17,416.13	R 17,992.35	R 17,992.35	R 23,033.90	R 23,033.90	R 23,033.90	R 23,033.90	R 23,033.90
NPV	8%	R 4,227,572.06									

Item	Year 11	12	13	14	15	16	17	18	19	20
Area under irrigation	20	20	20	20	20	20	20	20	20	20
Expenses										
Production cost	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00
Machines, equipment & tools etc										
O&M of infrastructure	R 4,093.78	R 4,093.78	R 4,093.78	R 4,093.78	R 4,093.78	R 4,093.78	R 4,093.78	R 4,093.78	R 4,093.78	R 4,093.78
Infrastructure loan repayments										
Working capital repayments	R 253,084.60	R 253,084.60	R 253,084.60	R 253,084.60	R 253,084.60	R 253,084.60	R 253,084.60	R 253,084.60	R 253,084.60	R 253,084.60
Sub-total	R 705,021.38	R 705,021.38	R 705,021.38	R 705,021.38	R 705,021.38	R 705,021.38	R 705,021.38	R 705,021.38	R 705,021.38	R 705,021.38
Income										
Gross income	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00
Subsidy										
Working capital loan	R 225,968.39	R 225,968.39	R 225,968.39	R 225,968.39	R 225,968.39	R 225,968.39	R 225,968.39	R 225,968.39	R 225,968.39	R 225,968.39
Sub-total	R 1,246,995.39	R 1,246,995.39	R 1,246,995.39	R 1,246,995.39	R 1,246,995.39	R 1,246,995.39	R 1,246,995.39	R 1,246,995.39	R 1,246,995.39	R 1,246,995.39
Net income	R 541,974.01	R 541,974.01	R 541,974.01	R 541,974.01	R 541,974.01	R 541,974.01	R 541,974.01	R 541,974.01	R 541,974.01	R 541,974.01
Tax	R 81,296.10	R 81,296.10	R 81,296.10	R 81,296.10	R 81,296.10	R 81,296.10	R 81,296.10	R 81,296.10	R 81,296.10	R 81,296.10
Net benefit of project	R 460,677.91	R 460,677.91	R 460,677.91	R 460,677.91	R 460,677.91	R 460,677.91	R 460,677.91	R 460,677.91	R 460,677.91	R 460,677.91
Return on investment	68.39%	68.39%	68.39%	68.39%	68.39%	68.39%	68.39%	68.39%	68.39%	68.39%
Average total net income per hectare	R 23,033.90	R 23,033.90	R 23,033.90	R 23,033.90	R 23,033.90	R 23,033.90	R 23,033.90	R 23,033.90	R 23,033.90	R 23,033.90
NPV										

Financial Analysis

Scheme Tamboekiesvlei
LOS Commercial

Item	Rate	Year																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Area under irrigation		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Expenses																					
Production cost	R 22,392.15	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00
Machines, equipment & tools etc																					
O&M of infrastructure		R 21,474.55	R 21,474.55	R 21,474.55	R 21,474.55	R 21,474.55	R 21,474.55	R 21,474.55	R 21,474.55	R 21,474.55	R 21,474.55	R 21,474.55	R 21,474.55	R 21,474.55	R 21,474.55	R 21,474.55	R 21,474.55	R 21,474.55	R 21,474.55	R 21,474.55	R 21,474.55
Infrastructure loan repayments	8%	R 1,299,627.65	R 1,299,627.65	R 1,299,627.65	R 1,299,627.65	R 1,299,627.65															
Working capital repayments	12%	R 525,635.66	R 525,635.66	R 394,226.74	R 262,817.83	R 262,817.83	R 262,817.83	R 262,817.83	R 262,817.83	R 262,817.83	R 262,817.83	R 262,817.83	R 262,817.83	R 262,817.83	R 262,817.83	R 262,817.83	R 262,817.83	R 262,817.83	R 262,817.83	R 262,817.83	R 262,817.83
Sub-total		R 2,294,580.86	R 2,294,580.86	R 2,163,171.95	R 2,031,763.03	R 2,031,763.03	R 732,135.38	R 732,135.38	R 732,135.38	R 732,135.38	R 732,135.38	R 732,135.38	R 732,135.38	R 732,135.38	R 732,135.38	R 732,135.38	R 732,135.38	R 732,135.38	R 732,135.38	R 732,135.38	R 732,135.38
Income																					
Gross income	R 51,051.35	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00
Subsidy		R 350,000.00																			
Working capital loan		R 469,317.55	R 469,317.55	R 351,988.16	R 234,658.78	R 234,658.78	R 234,658.78	R 234,658.78	R 234,658.78	R 234,658.78	R 234,658.78	R 234,658.78	R 234,658.78	R 234,658.78	R 234,658.78	R 234,658.78	R 234,658.78	R 234,658.78	R 234,658.78	R 234,658.78	R 234,658.78
Sub-total		R 1,840,344.55	R 1,490,344.55	R 1,373,015.16	R 1,255,685.78	R 1,255,685.78	R 1,255,685.78	R 1,255,685.78	R 1,255,685.78	R 1,255,685.78	R 1,255,685.78	R 1,255,685.78	R 1,255,685.78	R 1,255,685.78	R 1,255,685.78	R 1,255,685.78	R 1,255,685.78	R 1,255,685.78	R 1,255,685.78	R 1,255,685.78	R 1,255,685.78
Net income		-R 454,236.31	-R 804,236.31	-R 790,156.78	-R 776,077.26	-R 776,077.26	R 523,550.40	R 523,550.40	R 523,550.40	R 523,550.40	R 523,550.40	R 523,550.40	R 523,550.40	R 523,550.40	R 523,550.40	R 523,550.40	R 523,550.40	R 523,550.40	R 523,550.40	R 523,550.40	R 523,550.40
Tax	15%	R 0.00	R 0.00	R 0.00	R 0.00	R 0.00	R 78,532.56	R 78,532.56	R 78,532.56	R 78,532.56	R 78,532.56	R 78,532.56	R 78,532.56	R 78,532.56	R 78,532.56	R 78,532.56	R 78,532.56	R 78,532.56	R 78,532.56	R 78,532.56	R 78,532.56
Net benefit of project		-R 454,236.31	-R 804,236.31	-R 790,156.78	-R 776,077.26	-R 776,077.26	R 445,017.84	R 445,017.84	R 445,017.84	R 445,017.84	R 445,017.84	R 445,017.84	R 445,017.84	R 445,017.84	R 445,017.84	R 445,017.84	R 445,017.84	R 445,017.84	R 445,017.84	R 445,017.84	R 445,017.84
Return on investment		-8.20%	-14.52%	-14.27%	-14.01%	-14.01%	8.03%	8.03%	8.03%	8.03%	8.03%	8.03%	8.03%	8.03%	8.03%	8.03%	8.03%	8.03%	8.03%	8.03%	8.03%
Average total net income per hectare		-R 22,711.82	-R 40,211.82	-R 39,507.84	-R 38,803.86	-R 38,803.86	R 22,250.89	R 22,250.89	R 22,250.89	R 22,250.89	R 22,250.89	R 22,250.89	R 22,250.89	R 22,250.89	R 22,250.89	R 22,250.89	R 22,250.89	R 22,250.89	R 22,250.89	R 22,250.89	R 22,250.89
NPV	8%	-R 243,545.67																			

Financial Analysis

Scheme Ncambedlana
LOS Commercial

Item	Rate	Year																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Area under irrigation		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Expenses																					
Production cost	R 32,126.15	R 642,523.00	R 642,523.00	R 642,523.00	R 642,523.00	R 642,523.00	R 642,523.00	R 642,523.00	R 642,523.00	R 642,523.00	R 642,523.00	R 642,523.00	R 642,523.00	R 642,523.00	R 642,523.00	R 642,523.00	R 642,523.00	R 642,523.00	R 642,523.00	R 642,523.00	R 642,523.00
Machines, equipment & tools etc		R 56,525.00																			
O&M of infrastructure		R 159,550.07	R 159,550.07	R 159,550.07	R 159,550.07	R 159,550.07	R 159,550.07	R 159,550.07	R 159,550.07	R 159,550.07	R 159,550.07	R 159,550.07	R 159,550.07	R 159,550.07	R 159,550.07	R 159,550.07	R 159,550.07	R 159,550.07	R 159,550.07	R 159,550.07	R 159,550.07
Infrastructure loan repayments	8%	R 2,623,234.47	R 2,623,234.47	R 2,623,234.47	R 2,623,234.47	R 2,623,234.47															
Working capital repayments	12%	R 898,321.84	R 898,321.84	R 673,741.38	R 449,160.92	R 449,160.92	R 449,160.92	R 449,160.92	R 449,160.92	R 449,160.92	R 449,160.92	R 449,160.92	R 449,160.92	R 449,160.92	R 449,160.92	R 449,160.92	R 449,160.92	R 449,160.92	R 449,160.92	R 449,160.92	R 449,160.92
Sub-total		R 4,380,154.38	R 4,323,629.38	R 4,099,048.92	R 3,874,468.46	R 3,874,468.46	R 1,251,233.99	R 1,251,233.99	R 1,251,233.99	R 1,251,233.99	R 1,251,233.99	R 1,251,233.99	R 1,251,233.99	R 1,251,233.99	R 1,251,233.99	R 1,251,233.99	R 1,251,233.99	R 1,251,233.99	R 1,251,233.99	R 1,251,233.99	R 1,251,233.99
Income																					
Gross income	R 51,051.35	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00
Subsidy		R 850,000.00																			
Working capital loan		R 802,073.07	R 802,073.07	R 601,554.80	R 401,036.54	R 401,036.54	R 401,036.54	R 401,036.54	R 401,036.54	R 401,036.54	R 401,036.54	R 401,036.54	R 401,036.54	R 401,036.54	R 401,036.54	R 401,036.54	R 401,036.54	R 401,036.54	R 401,036.54	R 401,036.54	R 401,036.54
Sub-total		R 2,673,100.07	R 1,823,100.07	R 1,622,581.80	R 1,422,063.54	R 1,422,063.54	R 1,422,063.54	R 1,422,063.54	R 1,422,063.54	R 1,422,063.54	R 1,422,063.54	R 1,422,063.54	R 1,422,063.54	R 1,422,063.54	R 1,422,063.54	R 1,422,063.54	R 1,422,063.54	R 1,422,063.54	R 1,422,063.54	R 1,422,063.54	R 1,422,063.54
Net income		-R 1,707,054.31	-R 2,500,529.31	-R 2,476,467.11	-R 2,452,404.92	-R 2,452,404.92	R 170,829.55	R 170,829.55	R 170,829.55	R 170,829.55	R 170,829.55	R 170,829.55	R 170,829.55	R 170,829.55	R 170,829.55	R 170,829.55	R 170,829.55	R 170,829.55	R 170,829.55	R 170,829.55	R 170,829.55
Tax	15%	R 0.00	R 0.00	R 0.00	R 0.00	R 0.00	R 25,624.43	R 25,624.43	R 25,624.43	R 25,624.43	R 25,624.43	R 25,624.43	R 25,624.43	R 25,624.43	R 25,624.43	R 25,624.43	R 25,624.43	R 25,624.43	R 25,624.43	R 25,624.43	R 25,624.43
Net benefit of project		-R 1,707,054.31	-R 2,500,529.31	-R 2,476,467.11	-R 2,452,404.92	-R 2,452,404.92	R 145,205.11	R 145,205.11	R 145,205.11	R 145,205.11	R 145,205.11	R 145,205.11	R 145,205.11	R 145,205.11	R 145,205.11	R 145,205.11	R 145,205.11	R 145,205.11	R 145,205.11	R 145,205.11	R 145,205.11
Return on investment		-15.07%	-22.08%	-21.87%	-21.66%	-21.66%	1.28%	1.28%	1.28%	1.28%	1.28%	1.28%	1.28%	1.28%	1.28%	1.28%	1.28%	1.28%	1.28%	1.28%	1.28%
Average total net income per hectare		-R 85,352.72	-R 125,026.47	-R 123,823.36	-R 122,620.25	-R 122,620.25	R 7,260.26	R 7,260.26	R 7,260.26	R 7,260.26	R 7,260.26	R 7,260.26	R 7,260.26	R 7,260.26	R 7,260.26	R 7,260.26	R 7,260.26	R 7,260.26	R 7,260.26	R 7,260.26	R 7,260.26
NPV	8%	-R 8,316,079.23																			

Financial Analysis

Scheme Wolf River
LOS Commercial

Item	Rate	Year 1	2	3	4	5	6	7	8	9	10
Area under irrigation		20	20	20	20	20	20	20	20	20	20
Expenses											
Production cost	R 23,960.15	R 479,203.00	R 479,203.00	R 479,203.00	R 479,203.00	R 479,203.00	R 479,203.00	R 479,203.00	R 479,203.00	R 479,203.00	R 479,203.00
Machines, equipment & tools etc		R 0.00									
O&M of infrastructure		R 30,716.23	R 30,716.23	R 30,716.23	R 30,716.23	R 30,716.23	R 30,716.23	R 30,716.23	R 30,716.23	R 30,716.23	R 30,716.23
Infrastructure loan repayments	8%	R 244,372.65	R 244,372.65	R 244,372.65	R 244,372.65	R 244,372.65					
Working capital repayments	12%	R 571,109.54	R 571,109.54	R 428,332.15	R 285,554.77	R 285,554.77	R 285,554.77	R 285,554.77	R 285,554.77	R 285,554.77	R 285,554.77
Sub-total		R 1,325,401.42	R 1,325,401.42	R 1,182,624.03	R 1,039,846.65	R 1,039,846.65	R 795,474.00	R 795,474.00	R 795,474.00	R 795,474.00	R 795,474.00
Income											
Gross income	R 51,051.35	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00
Subsidy		R 180,000.00									
Working capital loan		R 509,919.23	R 509,919.23	R 382,439.42	R 254,959.62	R 254,959.62	R 254,959.62	R 254,959.62	R 254,959.62	R 254,959.62	R 254,959.62
Sub-total		R 1,710,946.23	R 1,530,946.23	R 1,403,466.42	R 1,275,986.62	R 1,275,986.62	R 1,275,986.62	R 1,275,986.62	R 1,275,986.62	R 1,275,986.62	R 1,275,986.62
Net income		R 385,544.81	R 205,544.81	R 220,842.39	R 236,139.97	R 236,139.97	R 480,512.62	R 480,512.62	R 480,512.62	R 480,512.62	R 480,512.62
Tax	15%	R 57,831.72	R 30,831.72	R 33,126.36	R 35,421.00	R 35,421.00	R 72,076.89	R 72,076.89	R 72,076.89	R 72,076.89	R 72,076.89
Net benefit of project		R 327,713.09	R 174,713.09	R 187,716.03	R 200,718.97	R 200,718.97	R 408,435.72	R 408,435.72	R 408,435.72	R 408,435.72	R 408,435.72
Return on investment		28.36%	15.12%	16.24%	17.37%	17.37%	35.34%	35.34%	35.34%	35.34%	35.34%
Average total net income per hectare		R 16,385.65	R 8,735.65	R 9,385.80	R 10,035.95	R 10,035.95	R 20,421.79	R 20,421.79	R 20,421.79	R 20,421.79	R 20,421.79
NPV	8%	R 3,265,698.53									

Item	Year 11	12	13	14	15	16	17	18	19	20
Area under irrigation	20	20	20	20	20	20	20	20	20	20
Expenses										
Production cost	R 479,203.00	R 479,203.00	R 479,203.00	R 479,203.00	R 479,203.00	R 479,203.00	R 479,203.00	R 479,203.00	R 479,203.00	R 479,203.00
Machines, equipment & tools etc										
O&M of infrastructure	R 30,716.23	R 30,716.23	R 30,716.23	R 30,716.23	R 30,716.23	R 30,716.23	R 30,716.23	R 30,716.23	R 30,716.23	R 30,716.23
Infrastructure loan repayments										
Working capital repayments	R 285,554.77	R 285,554.77	R 285,554.77	R 285,554.77	R 285,554.77	R 285,554.77	R 285,554.77	R 285,554.77	R 285,554.77	R 285,554.77
Sub-total	R 795,474.00	R 795,474.00	R 795,474.00	R 795,474.00	R 795,474.00	R 795,474.00	R 795,474.00	R 795,474.00	R 795,474.00	R 795,474.00
Income										
Gross income	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00
Subsidy										
Working capital loan	R 254,959.62	R 254,959.62	R 254,959.62	R 254,959.62	R 254,959.62	R 254,959.62	R 254,959.62	R 254,959.62	R 254,959.62	R 254,959.62
Sub-total	R 1,275,986.62	R 1,275,986.62	R 1,275,986.62	R 1,275,986.62	R 1,275,986.62	R 1,275,986.62	R 1,275,986.62	R 1,275,986.62	R 1,275,986.62	R 1,275,986.62
Net income	R 480,512.62	R 480,512.62	R 480,512.62	R 480,512.62	R 480,512.62	R 480,512.62	R 480,512.62	R 480,512.62	R 480,512.62	R 480,512.62
Tax	R 72,076.89	R 72,076.89	R 72,076.89	R 72,076.89	R 72,076.89	R 72,076.89	R 72,076.89	R 72,076.89	R 72,076.89	R 72,076.89
Net benefit of project	R 408,435.72	R 408,435.72	R 408,435.72	R 408,435.72	R 408,435.72	R 408,435.72	R 408,435.72	R 408,435.72	R 408,435.72	R 408,435.72
Return on investment	35.34%	35.34%	35.34%	35.34%	35.34%	35.34%	35.34%	35.34%	35.34%	35.34%
Average total net income per hectare	R 20,421.79	R 20,421.79	R 20,421.79	R 20,421.79	R 20,421.79	R 20,421.79	R 20,421.79	R 20,421.79	R 20,421.79	R 20,421.79
NPV										

Financial Analysis

Scheme Kama Furrow
LOS Commercial

Item	Rate	Year 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Area under irrigation		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Expenses																					
Production cost	R 22,392.15	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00	R 447,843.00
Machines, equipment & tools etc		R 12,000.00																			
O&M of infrastructure		R 121,126.29	R 121,126.29	R 121,126.29	R 121,126.29	R 121,126.29	R 121,126.29	R 121,126.29	R 121,126.29	R 121,126.29	R 121,126.29	R 121,126.29	R 121,126.29	R 121,126.29	R 121,126.29	R 121,126.29	R 121,126.29	R 121,126.29	R 121,126.29	R 121,126.29	R 121,126.29
Infrastructure loan repayments	8%	R 2,100,638.48	R 2,100,638.48	R 2,100,638.48	R 2,100,638.48	R 2,100,638.48															
Working capital repayments	12%	R 637,245.60	R 637,245.60	R 477,934.20	R 318,622.80	R 318,622.80	R 318,622.80	R 318,622.80	R 318,622.80	R 318,622.80	R 318,622.80	R 318,622.80	R 318,622.80	R 318,622.80	R 318,622.80	R 318,622.80	R 318,622.80	R 318,622.80	R 318,622.80	R 318,622.80	R 318,622.80
Sub-total		R 3,318,853.37	R 3,306,853.37	R 3,147,541.97	R 2,988,230.57	R 2,988,230.57	R 887,592.09	R 887,592.09	R 887,592.09	R 887,592.09	R 887,592.09	R 887,592.09	R 887,592.09	R 887,592.09	R 887,592.09	R 887,592.09	R 887,592.09	R 887,592.09	R 887,592.09	R 887,592.09	R 887,592.09
Income																					
Gross income	R 51,051.35	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00
Subsidy		R 371,000.00																			
Working capital loan		R 568,969.29	R 568,969.29	R 426,726.97	R 284,484.65	R 284,484.65	R 284,484.65	R 284,484.65	R 284,484.65	R 284,484.65	R 284,484.65	R 284,484.65	R 284,484.65	R 284,484.65	R 284,484.65	R 284,484.65	R 284,484.65	R 284,484.65	R 284,484.65	R 284,484.65	R 284,484.65
Sub-total		R 1,960,996.29	R 1,589,996.29	R 1,447,753.97	R 1,305,511.65	R 1,305,511.65	R 1,305,511.65	R 1,305,511.65	R 1,305,511.65	R 1,305,511.65	R 1,305,511.65	R 1,305,511.65	R 1,305,511.65	R 1,305,511.65	R 1,305,511.65	R 1,305,511.65	R 1,305,511.65	R 1,305,511.65	R 1,305,511.65	R 1,305,511.65	R 1,305,511.65
Net income		-R 1,357,857.08	-R 1,716,857.08	-R 1,699,788.00	-R 1,682,718.92	-R 1,682,718.92	R 417,919.55	R 417,919.55	R 417,919.55	R 417,919.55	R 417,919.55	R 417,919.55	R 417,919.55	R 417,919.55	R 417,919.55	R 417,919.55	R 417,919.55	R 417,919.55	R 417,919.55	R 417,919.55	R 417,919.55
Tax	15%	R 0.00	R 0.00	R 0.00	R 0.00	R 0.00	R 62,687.93	R 62,687.93	R 62,687.93	R 62,687.93	R 62,687.93	R 62,687.93	R 62,687.93	R 62,687.93	R 62,687.93	R 62,687.93	R 62,687.93	R 62,687.93	R 62,687.93	R 62,687.93	R 62,687.93
Net benefit of project		-R 1,357,857.08	-R 1,716,857.08	-R 1,699,788.00	-R 1,682,718.92	-R 1,682,718.92	R 355,231.62	R 355,231.62	R 355,231.62	R 355,231.62	R 355,231.62	R 355,231.62	R 355,231.62	R 355,231.62	R 355,231.62	R 355,231.62	R 355,231.62	R 355,231.62	R 355,231.62	R 355,231.62	R 355,231.62
Return on investment		-15.50%	-19.60%	-19.41%	-19.21%	-19.21%	4.06%	4.06%	4.06%	4.06%	4.06%	4.06%	4.06%	4.06%	4.06%	4.06%	4.06%	4.06%	4.06%	4.06%	4.06%
Average total net income per hectare		-R 67,892.85	-R 85,842.85	-R 84,989.40	-R 84,135.95	-R 84,135.95	R 17,761.58	R 17,761.58	R 17,761.58	R 17,761.58	R 17,761.58	R 17,761.58	R 17,761.58	R 17,761.58	R 17,761.58	R 17,761.58	R 17,761.58	R 17,761.58	R 17,761.58	R 17,761.58	R 17,761.58
NPV	8%	-R 4,391,249.14																			

Financial Analysis

Scheme Mantusini
LOS Commercial

Item	Rate	Year 1	2	3	4	5	6	7	8	9	10
Area under irrigation		20	20	20	20	20	20	20	20	20	20
Expenses											
Production cost	R 24,552.15	R 491,043.00	R 491,043.00	R 491,043.00	R 491,043.00	R 491,043.00	R 491,043.00	R 491,043.00	R 491,043.00	R 491,043.00	R 491,043.00
Machines, equipment & tools etc		R 0.00									
O&M of infrastructure		R 20,420.15	R 20,420.15	R 20,420.15	R 20,420.15	R 20,420.15	R 20,420.15	R 20,420.15	R 20,420.15	R 20,420.15	R 20,420.15
Infrastructure loan repayments	8%	R 556,715.18	R 556,715.18	R 556,715.18	R 556,715.18	R 556,715.18					
Working capital repayments	12%	R 572,838.73	R 572,838.73	R 429,629.05	R 286,419.36	R 286,419.36	R 286,419.36	R 286,419.36	R 286,419.36	R 286,419.36	R 286,419.36
Sub-total		R 1,641,017.05	R 1,641,017.05	R 1,497,807.37	R 1,354,597.69	R 1,354,597.69	R 797,882.51	R 797,882.51	R 797,882.51	R 797,882.51	R 797,882.51
Income											
Gross income	R 51,051.35	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00
Subsidy		R 300,000.00									
Working capital loan		R 511,463.15	R 511,463.15	R 383,597.36	R 255,731.58	R 255,731.58	R 255,731.58	R 255,731.58	R 255,731.58	R 255,731.58	R 255,731.58
Sub-total		R 1,832,490.15	R 1,532,490.15	R 1,404,624.36	R 1,276,758.58	R 1,276,758.58	R 1,276,758.58	R 1,276,758.58	R 1,276,758.58	R 1,276,758.58	R 1,276,758.58
Net income		R 191,473.10	-R 108,526.90	-R 93,183.01	-R 77,839.12	-R 77,839.12	R 478,876.06	R 478,876.06	R 478,876.06	R 478,876.06	R 478,876.06
Tax	15%	R 28,720.96	R 0.00	R 0.00	R 0.00	R 0.00	R 71,831.41	R 71,831.41	R 71,831.41	R 71,831.41	R 71,831.41
Net benefit of project		R 162,752.13	-R 108,526.90	-R 93,183.01	-R 77,839.12	-R 77,839.12	R 407,044.65	R 407,044.65	R 407,044.65	R 407,044.65	R 407,044.65
Return on investment		6.45%	-4.30%	-3.69%	-3.09%	-3.09%	16.13%	16.13%	16.13%	16.13%	16.13%
Average total net income per hectare		R 8,137.61	-R 5,426.35	-R 4,659.15	-R 3,891.96	-R 3,891.96	R 20,352.23	R 20,352.23	R 20,352.23	R 20,352.23	R 20,352.23
NPV	8%	R 2,244,703.47									

Item	Year 11	12	13	14	15	16	17	18	19	20
Area under irrigation	20	20	20	20	20	20	20	20	20	20
Expenses										
Production cost	R 491,043.00	R 491,043.00	R 491,043.00	R 491,043.00	R 491,043.00	R 491,043.00	R 491,043.00	R 491,043.00	R 491,043.00	R 491,043.00
Machines, equipment & tools etc										
O&M of infrastructure	R 20,420.15	R 20,420.15	R 20,420.15	R 20,420.15	R 20,420.15	R 20,420.15	R 20,420.15	R 20,420.15	R 20,420.15	R 20,420.15
Infrastructure loan repayments										
Working capital repayments	R 286,419.36	R 286,419.36	R 286,419.36	R 286,419.36	R 286,419.36	R 286,419.36	R 286,419.36	R 286,419.36	R 286,419.36	R 286,419.36
Sub-total	R 797,882.51	R 797,882.51	R 797,882.51	R 797,882.51	R 797,882.51	R 797,882.51	R 797,882.51	R 797,882.51	R 797,882.51	R 797,882.51
Income										
Gross income	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00	R 1,021,027.00
Subsidy										
Working capital loan	R 255,731.58	R 255,731.58	R 255,731.58	R 255,731.58	R 255,731.58	R 255,731.58	R 255,731.58	R 255,731.58	R 255,731.58	R 255,731.58
Sub-total	R 1,276,758.58	R 1,276,758.58	R 1,276,758.58	R 1,276,758.58	R 1,276,758.58	R 1,276,758.58	R 1,276,758.58	R 1,276,758.58	R 1,276,758.58	R 1,276,758.58
Net income	R 478,876.06	R 478,876.06	R 478,876.06	R 478,876.06	R 478,876.06	R 478,876.06	R 478,876.06	R 478,876.06	R 478,876.06	R 478,876.06
Tax	R 71,831.41	R 71,831.41	R 71,831.41	R 71,831.41	R 71,831.41	R 71,831.41	R 71,831.41	R 71,831.41	R 71,831.41	R 71,831.41
Net benefit of project	R 407,044.65	R 407,044.65	R 407,044.65	R 407,044.65	R 407,044.65	R 407,044.65	R 407,044.65	R 407,044.65	R 407,044.65	R 407,044.65
Return on investment	16.13%	16.13%	16.13%	16.13%	16.13%	16.13%	16.13%	16.13%	16.13%	16.13%
Average total net income per hectare	R 20,352.23	R 20,352.23	R 20,352.23	R 20,352.23	R 20,352.23	R 20,352.23	R 20,352.23	R 20,352.23	R 20,352.23	R 20,352.23
NPV										

APPENDIX Q

Smallholder LOS Financial Evaluation

Financial Analysis

Scheme Kruisfontein
LOS Smallholder

Item	Rate	Year																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Area under irrigation		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Expenses																					
Production cost	R 13,435.29	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80
Machines, equipment & tools etc																					
O&M of infrastructure		R 2,875.97	R 2,875.97	R 2,875.97	R 2,875.97	R 2,875.97	R 2,875.97	R 2,875.97	R 2,875.97	R 2,875.97	R 2,875.97	R 2,875.97	R 2,875.97	R 2,875.97	R 2,875.97	R 2,875.97	R 2,875.97	R 2,875.97	R 2,875.97	R 2,875.97	R 2,875.97
Infrastructure loan repayments	8%	R 68,553.14	R 68,553.14	R 68,553.14	R 68,553.14	R 68,553.14															
Working capital repayments	12%	R 304,171.58	R 304,171.58	R 228,128.69	R 152,085.79	R 152,085.79	R 152,085.79	R 152,085.79	R 152,085.79	R 152,085.79	R 152,085.79	R 152,085.79	R 152,085.79	R 152,085.79	R 152,085.79	R 152,085.79	R 152,085.79	R 152,085.79	R 152,085.79	R 152,085.79	R 152,085.79
Sub-total		R 644,306.49	R 644,306.49	R 568,263.60	R 492,220.70	R 492,220.70	R 423,667.56	R 423,667.56	R 423,667.56	R 423,667.56	R 423,667.56	R 423,667.56	R 423,667.56	R 423,667.56	R 423,667.56	R 423,667.56	R 423,667.56	R 423,667.56	R 423,667.56	R 423,667.56	R 423,667.56
Income																					
Gross income	R 30,630.81	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20
Subsidy		R 200,000.00																			
Working capital loan		R 271,581.77	R 271,581.77	R 203,686.33	R 135,790.89	R 135,790.89	R 135,790.89	R 135,790.89	R 135,790.89	R 135,790.89	R 135,790.89	R 135,790.89	R 135,790.89	R 135,790.89	R 135,790.89	R 135,790.89	R 135,790.89	R 135,790.89	R 135,790.89	R 135,790.89	R 135,790.89
Sub-total		R 1,084,197.97	R 884,197.97	R 816,302.53	R 748,407.09	R 748,407.09	R 748,407.09	R 748,407.09	R 748,407.09	R 748,407.09	R 748,407.09	R 748,407.09	R 748,407.09	R 748,407.09	R 748,407.09	R 748,407.09	R 748,407.09	R 748,407.09	R 748,407.09	R 748,407.09	R 748,407.09
Net income		R 439,891.48	R 239,891.48	R 248,038.93	R 256,186.38	R 256,186.38	R 324,739.52	R 324,739.52	R 324,739.52	R 324,739.52	R 324,739.52	R 324,739.52	R 324,739.52	R 324,739.52	R 324,739.52	R 324,739.52	R 324,739.52	R 324,739.52	R 324,739.52	R 324,739.52	R 324,739.52
Tax	15%	R 65,983.72	R 35,983.72	R 37,205.84	R 38,427.96	R 38,427.96	R 48,710.93	R 48,710.93	R 48,710.93	R 48,710.93	R 48,710.93	R 48,710.93	R 48,710.93	R 48,710.93	R 48,710.93	R 48,710.93	R 48,710.93	R 48,710.93	R 48,710.93	R 48,710.93	R 48,710.93
Net benefit of project		R 373,907.76	R 203,907.76	R 210,833.09	R 217,758.43	R 217,758.43	R 276,028.60	R 276,028.60	R 276,028.60	R 276,028.60	R 276,028.60	R 276,028.60	R 276,028.60	R 276,028.60	R 276,028.60	R 276,028.60	R 276,028.60	R 276,028.60	R 276,028.60	R 276,028.60	R 276,028.60
Return on investment		78.93%	43.04%	44.51%	45.97%	45.97%	58.27%	58.27%	58.27%	58.27%	58.27%	58.27%	58.27%	58.27%	58.27%	58.27%	58.27%	58.27%	58.27%	58.27%	58.27%
Average total net income per hectare		R 18,695.39	R 10,195.39	R 10,541.65	R 10,887.92	R 10,887.92	R 13,801.43	R 13,801.43	R 13,801.43	R 13,801.43	R 13,801.43	R 13,801.43	R 13,801.43	R 13,801.43	R 13,801.43	R 13,801.43	R 13,801.43	R 13,801.43	R 13,801.43	R 13,801.43	R 13,801.43
NPV	8%	R 2,604,643.99																			

Financial Analysis

Scheme Tamboekiesvlei
LOS Smallholder

Item	Rate	Year									
		1	2	3	4	5	6	7	8	9	10
Area under irrigation		20	20	20	20	20	20	20	20	20	20
Expenses											
Production cost	R 13,435.29	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80
Machines, equipment & tools etc											
O&M of infrastructure		R 14,946.39	R 14,946.39	R 14,946.39	R 14,946.39	R 14,946.39	R 14,946.39	R 14,946.39	R 14,946.39	R 14,946.39	R 14,946.39
Infrastructure loan repayments	8%	R 833,305.12	R 833,305.12	R 833,305.12	R 833,305.12	R 833,305.12					
Working capital repayments	12%	R 317,690.45	R 317,690.45	R 238,267.84	R 158,845.23	R 158,845.23	R 158,845.23	R 158,845.23	R 158,845.23	R 158,845.23	R 158,845.23
Sub-total		R 1,434,647.76	R 1,434,647.76	R 1,355,225.15	R 1,275,802.53	R 1,275,802.53	R 442,497.42	R 442,497.42	R 442,497.42	R 442,497.42	R 442,497.42
Income											
Gross income	R 30,630.81	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20
Subsidy		R 350,000.00									
Working capital loan		R 283,652.19	R 283,652.19	R 212,739.14	R 141,826.10	R 141,826.10	R 141,826.10	R 141,826.10	R 141,826.10	R 141,826.10	R 141,826.10
Sub-total		R 1,246,268.39	R 896,268.39	R 825,355.34	R 754,442.30	R 754,442.30	R 754,442.30	R 754,442.30	R 754,442.30	R 754,442.30	R 754,442.30
Net income		-R 188,379.37	-R 538,379.37	-R 529,869.80	-R 521,360.24	-R 521,360.24	R 311,944.88	R 311,944.88	R 311,944.88	R 311,944.88	R 311,944.88
Tax	15%	R 0.00	R 0.00	R 0.00	R 0.00	R 0.00	R 46,791.73	R 46,791.73	R 46,791.73	R 46,791.73	R 46,791.73
Net benefit of project		-R 188,379.37	-R 538,379.37	-R 529,869.80	-R 521,360.24	-R 521,360.24	R 265,153.15	R 265,153.15	R 265,153.15	R 265,153.15	R 265,153.15
Return on investment		-5.12%	-14.64%	-14.41%	-14.18%	-14.18%	7.21%	7.21%	7.21%	7.21%	7.21%
Average total net income per hectare		-R 9,418.97	-R 26,918.97	-R 26,493.49	-R 26,068.01	-R 26,068.01	R 13,257.66	R 13,257.66	R 13,257.66	R 13,257.66	R 13,257.66
NPV	8%	-R 250,037.92									

Item	Year									
	11	12	13	14	15	16	17	18	19	20
Area under irrigation	20	20	20	20	20	20	20	20	20	20
Expenses										
Production cost	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80
Machines, equipment & tools etc										
O&M of infrastructure	R 14,946.39	R 14,946.39	R 14,946.39	R 14,946.39	R 14,946.39	R 14,946.39	R 14,946.39	R 14,946.39	R 14,946.39	R 14,946.39
Infrastructure loan repayments										
Working capital repayments	R 158,845.23	R 158,845.23	R 158,845.23	R 158,845.23	R 158,845.23	R 158,845.23	R 158,845.23	R 158,845.23	R 158,845.23	R 158,845.23
Sub-total	R 442,497.42	R 442,497.42	R 442,497.42	R 442,497.42	R 442,497.42	R 442,497.42	R 442,497.42	R 442,497.42	R 442,497.42	R 442,497.42
Income										
Gross income	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20
Subsidy										
Working capital loan	R 141,826.10	R 141,826.10	R 141,826.10	R 141,826.10	R 141,826.10	R 141,826.10	R 141,826.10	R 141,826.10	R 141,826.10	R 141,826.10
Sub-total	R 754,442.30	R 754,442.30	R 754,442.30	R 754,442.30	R 754,442.30	R 754,442.30	R 754,442.30	R 754,442.30	R 754,442.30	R 754,442.30
Net income	R 311,944.88	R 311,944.88	R 311,944.88	R 311,944.88	R 311,944.88	R 311,944.88	R 311,944.88	R 311,944.88	R 311,944.88	R 311,944.88
Tax	R 46,791.73	R 46,791.73	R 46,791.73	R 46,791.73	R 46,791.73	R 46,791.73	R 46,791.73	R 46,791.73	R 46,791.73	R 46,791.73
Net benefit of project	R 265,153.15	R 265,153.15	R 265,153.15	R 265,153.15	R 265,153.15	R 265,153.15	R 265,153.15	R 265,153.15	R 265,153.15	R 265,153.15
Return on investment	7.21%	7.21%	7.21%	7.21%	7.21%	7.21%	7.21%	7.21%	7.21%	7.21%
Average total net income per hectare	R 13,257.66	R 13,257.66	R 13,257.66	R 13,257.66	R 13,257.66	R 13,257.66	R 13,257.66	R 13,257.66	R 13,257.66	R 13,257.66
NPV										

Financial Analysis

Scheme Ncambedlana
LOS Smallholder

Item	Rate	Year 1	2	3	4	5	6	7	8	9	10
Area under irrigation		20	20	20	20	20	20	20	20	20	20
Expenses											
Production cost	R 17,001.09	R 340,021.80	R 340,021.80	R 340,021.80	R 340,021.80	R 340,021.80	R 340,021.80	R 340,021.80	R 340,021.80	R 340,021.80	R 340,021.80
Machines, equipment & tools etc		R 56,525.00									
O&M of infrastructure		R 126,953.60	R 126,953.60	R 126,953.60	R 126,953.60	R 126,953.60	R 126,953.60	R 126,953.60	R 126,953.60	R 126,953.60	R 126,953.60
Infrastructure loan repayments	8%	R 708,076.89	R 708,076.89	R 708,076.89	R 708,076.89	R 708,076.89					
Working capital repayments	12%	R 523,012.45	R 523,012.45	R 392,259.34	R 261,506.22	R 261,506.22	R 261,506.22	R 261,506.22	R 261,506.22	R 261,506.22	R 261,506.22
Sub-total		R 1,754,589.74	R 1,698,064.74	R 1,567,311.63	R 1,436,558.51	R 1,436,558.51	R 728,481.62	R 728,481.62	R 728,481.62	R 728,481.62	R 728,481.62
Income											
Gross income	R 30,630.81	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20
Subsidy		R 850,000.00									
Working capital loan		R 466,975.40	R 466,975.40	R 350,231.55	R 233,487.70	R 233,487.70	R 233,487.70	R 233,487.70	R 233,487.70	R 233,487.70	R 233,487.70
Sub-total		R 1,929,591.60	R 1,079,591.60	R 962,847.75	R 846,103.90	R 846,103.90	R 846,103.90	R 846,103.90	R 846,103.90	R 846,103.90	R 846,103.90
Net income		R 175,001.86	-R 618,473.14	-R 604,463.88	-R 590,454.61	-R 590,454.61	R 117,622.28	R 117,622.28	R 117,622.28	R 117,622.28	R 117,622.28
Tax	15%	R 26,250.28	R 0.00	R 0.00	R 0.00	R 0.00	R 17,643.34	R 17,643.34	R 17,643.34	R 17,643.34	R 17,643.34
Net benefit of project		R 148,751.58	-R 618,473.14	-R 604,463.88	-R 590,454.61	-R 590,454.61	R 99,978.93	R 99,978.93	R 99,978.93	R 99,978.93	R 99,978.93
Return on investment		4.05%	-16.82%	-16.44%	-16.06%	-16.06%	2.72%	2.72%	2.72%	2.72%	2.72%
Average total net income per hectare		R 7,437.58	-R 30,923.66	-R 30,223.19	-R 29,522.73	-R 29,522.73	R 4,998.95	R 4,998.95	R 4,998.95	R 4,998.95	R 4,998.95
NPV	8%	-R 1,125,785.23									

Item	Year 11	12	13	14	15	16	17	18	19	20
Area under irrigation	20	20	20	20	20	20	20	20	20	20
Expenses										
Production cost	R 340,021.80	R 340,021.80	R 340,021.80	R 340,021.80	R 340,021.80	R 340,021.80	R 340,021.80	R 340,021.80	R 340,021.80	R 340,021.80
Machines, equipment & tools etc										
O&M of infrastructure	R 126,953.60	R 126,953.60	R 126,953.60	R 126,953.60	R 126,953.60	R 126,953.60	R 126,953.60	R 126,953.60	R 126,953.60	R 126,953.60
Infrastructure loan repayments										
Working capital repayments	R 261,506.22	R 261,506.22	R 261,506.22	R 261,506.22	R 261,506.22	R 261,506.22	R 261,506.22	R 261,506.22	R 261,506.22	R 261,506.22
Sub-total	R 728,481.62	R 728,481.62	R 728,481.62	R 728,481.62	R 728,481.62	R 728,481.62	R 728,481.62	R 728,481.62	R 728,481.62	R 728,481.62
Income										
Gross income	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20
Subsidy										
Working capital loan	R 233,487.70	R 233,487.70	R 233,487.70	R 233,487.70	R 233,487.70	R 233,487.70	R 233,487.70	R 233,487.70	R 233,487.70	R 233,487.70
Sub-total	R 846,103.90	R 846,103.90	R 846,103.90	R 846,103.90	R 846,103.90	R 846,103.90	R 846,103.90	R 846,103.90	R 846,103.90	R 846,103.90
Net income	R 117,622.28	R 117,622.28	R 117,622.28	R 117,622.28	R 117,622.28	R 117,622.28	R 117,622.28	R 117,622.28	R 117,622.28	R 117,622.28
Tax	R 17,643.34	R 17,643.34	R 17,643.34	R 17,643.34	R 17,643.34	R 17,643.34	R 17,643.34	R 17,643.34	R 17,643.34	R 17,643.34
Net benefit of project	R 99,978.93	R 99,978.93	R 99,978.93	R 99,978.93	R 99,978.93	R 99,978.93	R 99,978.93	R 99,978.93	R 99,978.93	R 99,978.93
Return on investment	2.72%	2.72%	2.72%	2.72%	2.72%	2.72%	2.72%	2.72%	2.72%	2.72%
Average total net income per hectare	R 4,998.95	R 4,998.95	R 4,998.95	R 4,998.95	R 4,998.95	R 4,998.95	R 4,998.95	R 4,998.95	R 4,998.95	R 4,998.95

Financial Analysis

Scheme Wolf River
LOS Smallholder

Item	Rate	Year 1	2	3	4	5	6	7	8	9	10
Area under irrigation		20	20	20	20	20	20	20	20	20	20
Expenses											
Production cost	R 14,023.89	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80
Machines, equipment & tools etc		R 0.00									
O&M of infrastructure		R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32
Infrastructure loan repayments	8%	R 233,891.52	R 233,891.52	R 233,891.52	R 233,891.52	R 233,891.52					
Working capital repayments	12%	R 347,029.89	R 347,029.89	R 260,272.42	R 173,514.95	R 173,514.95	R 173,514.95	R 173,514.95	R 173,514.95	R 173,514.95	R 173,514.95
Sub-total		R 890,769.53	R 890,769.53	R 804,012.06	R 717,254.58	R 717,254.58	R 483,363.07	R 483,363.07	R 483,363.07	R 483,363.07	R 483,363.07
Income											
Gross income	R 30,630.81	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20
Subsidy		R 180,000.00									
Working capital loan		R 309,848.12	R 309,848.12	R 232,386.09	R 154,924.06	R 154,924.06	R 154,924.06	R 154,924.06	R 154,924.06	R 154,924.06	R 154,924.06
Sub-total		R 1,102,464.32	R 922,464.32	R 845,002.29	R 767,540.26	R 767,540.26	R 767,540.26	R 767,540.26	R 767,540.26	R 767,540.26	R 767,540.26
Net income		R 211,694.79	R 31,694.79	R 40,990.23	R 50,285.68	R 50,285.68	R 284,177.19	R 284,177.19	R 284,177.19	R 284,177.19	R 284,177.19
Tax	15%	R 31,754.22	R 4,754.22	R 6,148.54	R 7,542.85	R 7,542.85	R 42,626.58	R 42,626.58	R 42,626.58	R 42,626.58	R 42,626.58
Net benefit of project		R 179,940.57	R 26,940.57	R 34,841.70	R 42,742.83	R 42,742.83	R 241,550.61	R 241,550.61	R 241,550.61	R 241,550.61	R 241,550.61
Return on investment		16.15%	2.42%	3.13%	3.84%	3.84%	21.69%	21.69%	21.69%	21.69%	21.69%
Average total net income per hectare		R 8,997.03	R 1,347.03	R 1,742.08	R 2,137.14	R 2,137.14	R 12,077.53	R 12,077.53	R 12,077.53	R 12,077.53	R 12,077.53
NPV	8%	R 1,685,012.58									

Item	Year 11	12	13	14	15	16	17	18	19	20
Area under irrigation	20	20	20	20	20	20	20	20	20	20
Expenses										
Production cost	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80
Machines, equipment & tools etc										
O&M of infrastructure	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32
Infrastructure loan repayments										
Working capital repayments	R 173,514.95	R 173,514.95	R 173,514.95	R 173,514.95	R 173,514.95	R 173,514.95	R 173,514.95	R 173,514.95	R 173,514.95	R 173,514.95
Sub-total	R 483,363.07	R 483,363.07	R 483,363.07	R 483,363.07	R 483,363.07	R 483,363.07	R 483,363.07	R 483,363.07	R 483,363.07	R 483,363.07
Income										
Gross income	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20
Subsidy										
Working capital loan	R 154,924.06	R 154,924.06	R 154,924.06	R 154,924.06	R 154,924.06	R 154,924.06	R 154,924.06	R 154,924.06	R 154,924.06	R 154,924.06
Sub-total	R 767,540.26	R 767,540.26	R 767,540.26	R 767,540.26	R 767,540.26	R 767,540.26	R 767,540.26	R 767,540.26	R 767,540.26	R 767,540.26
Net income	R 284,177.19	R 284,177.19	R 284,177.19	R 284,177.19	R 284,177.19	R 284,177.19	R 284,177.19	R 284,177.19	R 284,177.19	R 284,177.19
Tax	R 42,626.58	R 42,626.58	R 42,626.58	R 42,626.58	R 42,626.58	R 42,626.58	R 42,626.58	R 42,626.58	R 42,626.58	R 42,626.58
Net benefit of project	R 241,550.61	R 241,550.61	R 241,550.61	R 241,550.61	R 241,550.61	R 241,550.61	R 241,550.61	R 241,550.61	R 241,550.61	R 241,550.61
Return on investment	21.69%	21.69%	21.69%	21.69%	21.69%	21.69%	21.69%	21.69%	21.69%	21.69%
Average total net income per hectare	R 12,077.53	R 12,077.53	R 12,077.53	R 12,077.53	R 12,077.53	R 12,077.53	R 12,077.53	R 12,077.53	R 12,077.53	R 12,077.53

Financial Analysis

Scheme Kama Furrow
LOS Smallholder

Item	Rate	Year																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Area under irrigation		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Expenses																					
Production cost	R 13,435.29	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80
Machines, equipment & tools etc																					
O&M of infrastructure		R 113,392.24	R 113,392.24	R 113,392.24	R 113,392.24	R 113,392.24	R 113,392.24	R 113,392.24	R 113,392.24	R 113,392.24	R 113,392.24	R 113,392.24	R 113,392.24	R 113,392.24	R 113,392.24	R 113,392.24	R 113,392.24	R 113,392.24	R 113,392.24	R 113,392.24	R 113,392.24
Infrastructure loan repayments	8%	R 1,739,392.61	R 1,739,392.61	R 1,739,392.61	R 1,739,392.61	R 1,739,392.61															
Working capital repayments	12%	R 427,949.80	R 427,949.80	R 320,962.35	R 213,974.90	R 213,974.90	R 213,974.90	R 213,974.90	R 213,974.90	R 213,974.90	R 213,974.90	R 213,974.90	R 213,974.90	R 213,974.90	R 213,974.90	R 213,974.90	R 213,974.90	R 213,974.90	R 213,974.90	R 213,974.90	R 213,974.90
Sub-total		R 2,549,440.45	R 2,549,440.45	R 2,442,453.00	R 2,335,465.55	R 2,335,465.55	R 596,072.94	R 596,072.94	R 596,072.94	R 596,072.94	R 596,072.94	R 596,072.94	R 596,072.94	R 596,072.94	R 596,072.94	R 596,072.94	R 596,072.94	R 596,072.94	R 596,072.94	R 596,072.94	R 596,072.94
Income																					
Gross income	R 30,630.81	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20
Subsidy		R 371,000.00																			
Working capital loan		R 382,098.04	R 382,098.04	R 286,573.53	R 191,049.02	R 191,049.02	R 191,049.02	R 191,049.02	R 191,049.02	R 191,049.02	R 191,049.02	R 191,049.02	R 191,049.02	R 191,049.02	R 191,049.02	R 191,049.02	R 191,049.02	R 191,049.02	R 191,049.02	R 191,049.02	R 191,049.02
Sub-total		R 1,365,714.24	R 994,714.24	R 899,189.73	R 803,665.22	R 803,665.22	R 803,665.22	R 803,665.22	R 803,665.22	R 803,665.22	R 803,665.22	R 803,665.22	R 803,665.22	R 803,665.22	R 803,665.22	R 803,665.22	R 803,665.22	R 803,665.22	R 803,665.22	R 803,665.22	R 803,665.22
Net income		-R 1,183,726.21	-R 1,554,726.21	-R 1,543,263.27	-R 1,531,800.33	-R 1,531,800.33	R 207,592.28	R 207,592.28	R 207,592.28	R 207,592.28	R 207,592.28	R 207,592.28	R 207,592.28	R 207,592.28	R 207,592.28	R 207,592.28	R 207,592.28	R 207,592.28	R 207,592.28	R 207,592.28	R 207,592.28
Tax	15%	R 0.00	R 0.00	R 0.00	R 0.00	R 0.00	R 31,138.84	R 31,138.84	R 31,138.84	R 31,138.84	R 31,138.84	R 31,138.84	R 31,138.84	R 31,138.84	R 31,138.84	R 31,138.84	R 31,138.84	R 31,138.84	R 31,138.84	R 31,138.84	R 31,138.84
Net benefit of project		-R 1,183,726.21	-R 1,554,726.21	-R 1,543,263.27	-R 1,531,800.33	-R 1,531,800.33	R 176,453.44	R 176,453.44	R 176,453.44	R 176,453.44	R 176,453.44	R 176,453.44	R 176,453.44	R 176,453.44	R 176,453.44	R 176,453.44	R 176,453.44	R 176,453.44	R 176,453.44	R 176,453.44	R 176,453.44
Return on investment		-16.18%	-21.25%	-21.09%	-20.94%	-20.94%	2.41%	2.41%	2.41%	2.41%	2.41%	2.41%	2.41%	2.41%	2.41%	2.41%	2.41%	2.41%	2.41%	2.41%	2.41%
Average total net income per hectare		-R 59,186.31	-R 77,736.31	-R 77,163.16	-R 76,590.02	-R 76,590.02	R 8,822.67	R 8,822.67	R 8,822.67	R 8,822.67	R 8,822.67	R 8,822.67	R 8,822.67	R 8,822.67	R 8,822.67	R 8,822.67	R 8,822.67	R 8,822.67	R 8,822.67	R 8,822.67	R 8,822.67
NPV	8%	-R 4,794,580.16																			

Financial Analysis

Scheme Mantusini
LOS Smallholder

Item	Rate	Year									
		1	2	3	4	5	6	7	8	9	10
Area under irrigation		20	20	20	20	20	20	20	20	20	20
Expenses											
Production cost	R 14,380.89	R 287,617.80	R 287,617.80	R 287,617.80	R 287,617.80	R 287,617.80	R 287,617.80	R 287,617.80	R 287,617.80	R 287,617.80	R 287,617.80
Machines, equipment & tools etc		R 0.00									
O&M of infrastructure		R 18,980.20	R 18,980.20	R 18,980.20	R 18,980.20	R 18,980.20	R 18,980.20	R 18,980.20	R 18,980.20	R 18,980.20	R 18,980.20
Infrastructure loan repayments	8%	R 495,677.11	R 495,677.11	R 495,677.11	R 495,677.11	R 495,677.11					
Working capital repayments	12%	R 343,389.76	R 343,389.76	R 257,542.32	R 171,694.88	R 171,694.88	R 171,694.88	R 171,694.88	R 171,694.88	R 171,694.88	R 171,694.88
Sub-total		R 1,145,664.87	R 1,145,664.87	R 1,059,817.43	R 973,969.99	R 973,969.99	R 478,292.88	R 478,292.88	R 478,292.88	R 478,292.88	R 478,292.88
Income											
Gross income	R 30,630.81	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20
Subsidy		R 300,000.00									
Working capital loan		R 306,598.00	R 306,598.00	R 229,948.50	R 153,299.00	R 153,299.00	R 153,299.00	R 153,299.00	R 153,299.00	R 153,299.00	R 153,299.00
Sub-total		R 1,219,214.20	R 919,214.20	R 842,564.70	R 765,915.20	R 765,915.20	R 765,915.20	R 765,915.20	R 765,915.20	R 765,915.20	R 765,915.20
Net income		R 73,549.33	-R 226,450.67	-R 217,252.73	-R 208,054.79	-R 208,054.79	R 287,622.32	R 287,622.32	R 287,622.32	R 287,622.32	R 287,622.32
Tax	15%	R 11,032.40	R 0.00	R 0.00	R 0.00	R 0.00	R 43,143.35	R 43,143.35	R 43,143.35	R 43,143.35	R 43,143.35
Net benefit of project		R 62,516.93	-R 226,450.67	-R 217,252.73	-R 208,054.79	-R 208,054.79	R 244,478.97	R 244,478.97	R 244,478.97	R 244,478.97	R 244,478.97
Return on investment		2.74%	-9.94%	-9.53%	-9.13%	-9.13%	10.73%	10.73%	10.73%	10.73%	10.73%
Average total net income per hectare		R 3,125.85	-R 11,322.53	-R 10,862.64	-R 10,402.74	-R 10,402.74	R 12,223.95	R 12,223.95	R 12,223.95	R 12,223.95	R 12,223.95
NPV	8%	R 820,950.74									

Item	Year									
	11	12	13	14	15	16	17	18	19	20
Area under irrigation	20	20	20	20	20	20	20	20	20	20
Expenses										
Production cost	R 287,617.80	R 287,617.80	R 287,617.80	R 287,617.80	R 287,617.80	R 287,617.80	R 287,617.80	R 287,617.80	R 287,617.80	R 287,617.80
Machines, equipment & tools etc										
O&M of infrastructure	R 18,980.20	R 18,980.20	R 18,980.20	R 18,980.20	R 18,980.20	R 18,980.20	R 18,980.20	R 18,980.20	R 18,980.20	R 18,980.20
Infrastructure loan repayments										
Working capital repayments	R 171,694.88	R 171,694.88	R 171,694.88	R 171,694.88	R 171,694.88	R 171,694.88	R 171,694.88	R 171,694.88	R 171,694.88	R 171,694.88
Sub-total	R 478,292.88	R 478,292.88	R 478,292.88	R 478,292.88	R 478,292.88	R 478,292.88	R 478,292.88	R 478,292.88	R 478,292.88	R 478,292.88
Income										
Gross income	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20
Subsidy										
Working capital loan	R 153,299.00	R 153,299.00	R 153,299.00	R 153,299.00	R 153,299.00	R 153,299.00	R 153,299.00	R 153,299.00	R 153,299.00	R 153,299.00
Sub-total	R 765,915.20	R 765,915.20	R 765,915.20	R 765,915.20	R 765,915.20	R 765,915.20	R 765,915.20	R 765,915.20	R 765,915.20	R 765,915.20
Net income	R 287,622.32	R 287,622.32	R 287,622.32	R 287,622.32	R 287,622.32	R 287,622.32	R 287,622.32	R 287,622.32	R 287,622.32	R 287,622.32
Tax	R 43,143.35	R 43,143.35	R 43,143.35	R 43,143.35	R 43,143.35	R 43,143.35	R 43,143.35	R 43,143.35	R 43,143.35	R 43,143.35
Net benefit of project	R 244,478.97	R 244,478.97	R 244,478.97	R 244,478.97	R 244,478.97	R 244,478.97	R 244,478.97	R 244,478.97	R 244,478.97	R 244,478.97
Return on investment	10.73%	10.73%	10.73%	10.73%	10.73%	10.73%	10.73%	10.73%	10.73%	10.73%
Average total net income per hectare	R 12,223.95	R 12,223.95	R 12,223.95	R 12,223.95	R 12,223.95	R 12,223.95	R 12,223.95	R 12,223.95	R 12,223.95	R 12,223.95

APPENDIX R

Commercial Under-utilised Financial Evaluation

Financial Analysis

Scheme Kruisfontein
LOS Commercial-underutilised

Item	Rate	Year																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Area under irrigation		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Expenses																					
Production cost	R 13,435.29	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80
Machines, equipment & tools etc																					
O&M of infrastructure		R 3,827.98	R 3,827.98	R 3,827.98	R 3,827.98	R 3,827.98	R 3,827.98	R 3,827.98	R 3,827.98	R 3,827.98	R 3,827.98	R 3,827.98	R 3,827.98	R 3,827.98	R 3,827.98	R 3,827.98	R 3,827.98	R 3,827.98	R 3,827.98	R 3,827.98	R 3,827.98
Infrastructure loan repayments	8%	R 118,624.57	R 118,624.57	R 118,624.57	R 118,624.57	R 118,624.57															
Working capital repayments	12%	R 305,237.83	R 305,237.83	R 228,928.38	R 152,618.92	R 152,618.92	R 152,618.92	R 152,618.92	R 152,618.92	R 152,618.92	R 152,618.92	R 152,618.92	R 152,618.92	R 152,618.92	R 152,618.92	R 152,618.92	R 152,618.92	R 152,618.92	R 152,618.92	R 152,618.92	R 152,618.92
Sub-total		R 696,396.18	R 696,396.18	R 620,086.72	R 543,777.27	R 543,777.27	R 425,152.70	R 425,152.70	R 425,152.70	R 425,152.70	R 425,152.70	R 425,152.70	R 425,152.70	R 425,152.70	R 425,152.70	R 425,152.70	R 425,152.70	R 425,152.70	R 425,152.70	R 425,152.70	R 425,152.70
Income																					
Gross income	R 30,630.81	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20
Subsidy		R 200,000.00																			
Working capital loan		R 272,533.78	R 272,533.78	R 204,400.34	R 136,266.89	R 136,266.89	R 136,266.89	R 136,266.89	R 136,266.89	R 136,266.89	R 136,266.89	R 136,266.89	R 136,266.89	R 136,266.89	R 136,266.89	R 136,266.89	R 136,266.89	R 136,266.89	R 136,266.89	R 136,266.89	R 136,266.89
Sub-total		R 1,085,149.98	R 885,149.98	R 817,016.54	R 748,883.09	R 748,883.09	R 748,883.09	R 748,883.09	R 748,883.09	R 748,883.09	R 748,883.09	R 748,883.09	R 748,883.09	R 748,883.09	R 748,883.09	R 748,883.09	R 748,883.09	R 748,883.09	R 748,883.09	R 748,883.09	R 748,883.09
Net income		R 388,753.80	R 188,753.80	R 196,929.81	R 205,105.82	R 205,105.82	R 323,730.39	R 323,730.39	R 323,730.39	R 323,730.39	R 323,730.39	R 323,730.39	R 323,730.39	R 323,730.39	R 323,730.39	R 323,730.39	R 323,730.39	R 323,730.39	R 323,730.39	R 323,730.39	R 323,730.39
Tax	15%	R 58,313.07	R 28,313.07	R 29,539.47	R 30,765.87	R 30,765.87	R 48,559.56	R 48,559.56	R 48,559.56	R 48,559.56	R 48,559.56	R 48,559.56	R 48,559.56	R 48,559.56	R 48,559.56	R 48,559.56	R 48,559.56	R 48,559.56	R 48,559.56	R 48,559.56	R 48,559.56
Net benefit of project		R 330,440.73	R 160,440.73	R 167,390.34	R 174,339.95	R 174,339.95	R 275,170.83	R 275,170.83	R 275,170.83	R 275,170.83	R 275,170.83	R 275,170.83	R 275,170.83	R 275,170.83	R 275,170.83	R 275,170.83	R 275,170.83	R 275,170.83	R 275,170.83	R 275,170.83	R 275,170.83
Return on investment		49.05%	23.82%	24.85%	25.88%	25.88%	40.85%	40.85%	40.85%	40.85%	40.85%	40.85%	40.85%	40.85%	40.85%	40.85%	40.85%	40.85%	40.85%	40.85%	40.85%
Average total net income per hectare		R 16,522.04	R 8,022.04	R 8,369.52	R 8,717.00	R 8,717.00	R 13,758.54	R 13,758.54	R 13,758.54	R 13,758.54	R 13,758.54	R 13,758.54	R 13,758.54	R 13,758.54	R 13,758.54	R 13,758.54	R 13,758.54	R 13,758.54	R 13,758.54	R 13,758.54	R 13,758.54
NPV	8%	R 2,426,183.92																			

Financial Analysis

Scheme Tamboekiesvlei
LOS Commercial-underutilised

Item	Rate	Year 1	2	3	4	5	6	7	8	9	10
Area under irrigation		20	20	20	20	20	20	20	20	20	20
Expenses											
Production cost	R 13,435.29	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80
Machines, equipment & tools etc											
O&M of infrastructure		R 20,924.01	R 20,924.01	R 20,924.01	R 20,924.01	R 20,924.01	R 20,924.01	R 20,924.01	R 20,924.01	R 20,924.01	R 20,924.01
Infrastructure loan repayments	8%	R 1,299,627.65	R 1,299,627.65	R 1,299,627.65	R 1,299,627.65	R 1,299,627.65					
Working capital repayments	12%	R 324,385.39	R 324,385.39	R 243,289.04	R 162,192.69	R 162,192.69	R 162,192.69	R 162,192.69	R 162,192.69	R 162,192.69	R 162,192.69
Sub-total		R 1,913,642.85	R 1,913,642.85	R 1,832,546.50	R 1,751,450.16	R 1,751,450.16	R 451,822.50	R 451,822.50	R 451,822.50	R 451,822.50	R 451,822.50
Income											
Gross income	R 30,630.81	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20
Subsidy		R 350,000.00									
Working capital loan		R 289,629.81	R 289,629.81	R 217,222.36	R 144,814.91	R 144,814.91	R 144,814.91	R 144,814.91	R 144,814.91	R 144,814.91	R 144,814.91
Sub-total		R 1,252,246.01	R 902,246.01	R 829,838.56	R 757,431.11	R 757,431.11	R 757,431.11	R 757,431.11	R 757,431.11	R 757,431.11	R 757,431.11
Net income		-R 661,396.84	-R 1,011,396.84	-R 1,002,707.95	-R 994,019.05	-R 994,019.05	R 305,608.60	R 305,608.60	R 305,608.60	R 305,608.60	R 305,608.60
Tax	15%	R 0.00	R 0.00	R 0.00	R 0.00	R 0.00	R 45,841.29	R 45,841.29	R 45,841.29	R 45,841.29	R 45,841.29
Net benefit of project		-R 661,396.84	-R 1,011,396.84	-R 1,002,707.95	-R 994,019.05	-R 994,019.05	R 259,767.31	R 259,767.31	R 259,767.31	R 259,767.31	R 259,767.31
Return on investment		-11.94%	-18.26%	-18.10%	-17.95%	-17.95%	4.69%	4.69%	4.69%	4.69%	4.69%
Average total net income per hectare		-R 33,069.84	-R 50,569.84	-R 50,135.40	-R 49,700.95	-R 49,700.95	R 12,988.37	R 12,988.37	R 12,988.37	R 12,988.37	R 12,988.37
NPV	8%	-R 2,169,384.29									

Item	Year 11	12	13	14	15	16	17	18	19	20
Area under irrigation	20	20	20	20	20	20	20	20	20	20
Expenses										
Production cost	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80
Machines, equipment & tools etc										
O&M of infrastructure	R 20,924.01	R 20,924.01	R 20,924.01	R 20,924.01	R 20,924.01	R 20,924.01	R 20,924.01	R 20,924.01	R 20,924.01	R 20,924.01
Infrastructure loan repayments										
Working capital repayments	R 162,192.69	R 162,192.69	R 162,192.69	R 162,192.69	R 162,192.69	R 162,192.69	R 162,192.69	R 162,192.69	R 162,192.69	R 162,192.69
Sub-total	R 451,822.50	R 451,822.50	R 451,822.50	R 451,822.50	R 451,822.50	R 451,822.50	R 451,822.50	R 451,822.50	R 451,822.50	R 451,822.50
Income										
Gross income	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20
Subsidy										
Working capital loan	R 144,814.91	R 144,814.91	R 144,814.91	R 144,814.91	R 144,814.91	R 144,814.91	R 144,814.91	R 144,814.91	R 144,814.91	R 144,814.91
Sub-total	R 757,431.11	R 757,431.11	R 757,431.11	R 757,431.11	R 757,431.11	R 757,431.11	R 757,431.11	R 757,431.11	R 757,431.11	R 757,431.11
Net income	R 305,608.60	R 305,608.60	R 305,608.60	R 305,608.60	R 305,608.60	R 305,608.60	R 305,608.60	R 305,608.60	R 305,608.60	R 305,608.60
Tax	R 45,841.29	R 45,841.29	R 45,841.29	R 45,841.29	R 45,841.29	R 45,841.29	R 45,841.29	R 45,841.29	R 45,841.29	R 45,841.29
Net benefit of project	R 259,767.31	R 259,767.31	R 259,767.31	R 259,767.31	R 259,767.31	R 259,767.31	R 259,767.31	R 259,767.31	R 259,767.31	R 259,767.31
Return on investment	4.69%	4.69%	4.69%	4.69%	4.69%	4.69%	4.69%	4.69%	4.69%	4.69%
Average total net income per hectare	R 12,988.37	R 12,988.37	R 12,988.37	R 12,988.37	R 12,988.37	R 12,988.37	R 12,988.37	R 12,988.37	R 12,988.37	R 12,988.37
NPV										

Financial Analysis

Scheme Ncambedlana
LOS Commercial-underutilised

Item	Rate	Year																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Area under irrigation		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Expenses																					
Production cost	R 18,489.09	R 369,781.80	R 369,781.80	R 369,781.80	R 369,781.80	R 369,781.80	R 369,781.80	R 369,781.80	R 369,781.80	R 369,781.80	R 369,781.80	R 369,781.80	R 369,781.80	R 369,781.80	R 369,781.80	R 369,781.80	R 369,781.80	R 369,781.80	R 369,781.80	R 369,781.80	R 369,781.80
Machines, equipment & tools etc		R 56,525.00																			
O&M of infrastructure		R 158,814.37	R 158,814.37	R 158,814.37	R 158,814.37	R 158,814.37	R 158,814.37	R 158,814.37	R 158,814.37	R 158,814.37	R 158,814.37	R 158,814.37	R 158,814.37	R 158,814.37	R 158,814.37	R 158,814.37	R 158,814.37	R 158,814.37	R 158,814.37	R 158,814.37	R 158,814.37
Infrastructure loan repayments	8%	R 2,623,234.47	R 2,623,234.47	R 2,623,234.47	R 2,623,234.47	R 2,623,234.47															
Working capital repayments	12%	R 592,027.71	R 592,027.71	R 444,020.78	R 296,013.86	R 296,013.86	R 296,013.86	R 296,013.86	R 296,013.86	R 296,013.86	R 296,013.86	R 296,013.86	R 296,013.86	R 296,013.86	R 296,013.86	R 296,013.86	R 296,013.86	R 296,013.86	R 296,013.86	R 296,013.86	R 296,013.86
Sub-total		R 3,800,383.35	R 3,743,858.35	R 3,595,851.42	R 3,447,844.49	R 3,447,844.49	R 824,610.03	R 824,610.03	R 824,610.03	R 824,610.03	R 824,610.03	R 824,610.03	R 824,610.03	R 824,610.03	R 824,610.03	R 824,610.03	R 824,610.03	R 824,610.03	R 824,610.03	R 824,610.03	R 824,610.03
Income																					
Gross income	R 30,630.81	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20
Subsidy		R 850,000.00																			
Working capital loan		R 528,596.17	R 528,596.17	R 396,447.13	R 264,298.09	R 264,298.09	R 264,298.09	R 264,298.09	R 264,298.09	R 264,298.09	R 264,298.09	R 264,298.09	R 264,298.09	R 264,298.09	R 264,298.09	R 264,298.09	R 264,298.09	R 264,298.09	R 264,298.09	R 264,298.09	R 264,298.09
Sub-total		R 1,991,212.37	R 1,141,212.37	R 1,009,063.33	R 876,914.29	R 876,914.29	R 876,914.29	R 876,914.29	R 876,914.29	R 876,914.29	R 876,914.29	R 876,914.29	R 876,914.29	R 876,914.29	R 876,914.29	R 876,914.29	R 876,914.29	R 876,914.29	R 876,914.29	R 876,914.29	R 876,914.29
Net income		-R 1,809,170.98	-R 2,602,645.98	-R 2,586,788.09	-R 2,570,930.21	-R 2,570,930.21	R 52,304.26	R 52,304.26	R 52,304.26	R 52,304.26	R 52,304.26	R 52,304.26	R 52,304.26	R 52,304.26	R 52,304.26	R 52,304.26	R 52,304.26	R 52,304.26	R 52,304.26	R 52,304.26	R 52,304.26
Tax	15%	R 0.00	R 0.00	R 0.00	R 0.00	R 0.00	R 7,845.64	R 7,845.64	R 7,845.64	R 7,845.64	R 7,845.64	R 7,845.64	R 7,845.64	R 7,845.64	R 7,845.64	R 7,845.64	R 7,845.64	R 7,845.64	R 7,845.64	R 7,845.64	R 7,845.64
Net benefit of project		-R 1,809,170.98	-R 2,602,645.98	-R 2,586,788.09	-R 2,570,930.21	-R 2,570,930.21	R 44,458.62	R 44,458.62	R 44,458.62	R 44,458.62	R 44,458.62	R 44,458.62	R 44,458.62	R 44,458.62	R 44,458.62	R 44,458.62	R 44,458.62	R 44,458.62	R 44,458.62	R 44,458.62	R 44,458.62
Return on investment		-15.98%	-22.98%	-22.84%	-22.70%	-22.70%	0.39%	0.39%	0.39%	0.39%	0.39%	0.39%	0.39%	0.39%	0.39%	0.39%	0.39%	0.39%	0.39%	0.39%	0.39%
Average total net income per hectare		-R 90,458.55	-R 130,132.30	-R 129,339.40	-R 128,546.51	-R 128,546.51	R 2,222.93	R 2,222.93	R 2,222.93	R 2,222.93	R 2,222.93	R 2,222.93	R 2,222.93	R 2,222.93	R 2,222.93	R 2,222.93	R 2,222.93	R 2,222.93	R 2,222.93	R 2,222.93	R 2,222.93
NPV	8%	-R 9,340,434.97																			

Financial Analysis

Scheme Wolf River
LOS Smallholder

Item	Rate	Year									
		1	2	3	4	5	6	7	8	9	10
Area under irrigation		20	20	20	20	20	20	20	20	20	20
Expenses											
Production cost	R 14,023.89	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80
Machines, equipment & tools etc		R 0.00									
O&M of infrastructure		R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32
Infrastructure loan repayments	8%	R 233,891.52	R 233,891.52	R 233,891.52	R 233,891.52	R 233,891.52					
Working capital repayments	12%	R 347,029.89	R 347,029.89	R 260,272.42	R 173,514.95	R 173,514.95	R 173,514.95	R 173,514.95	R 173,514.95	R 173,514.95	R 173,514.95
Sub-total		R 890,769.53	R 890,769.53	R 804,012.06	R 717,254.58	R 717,254.58	R 483,363.07	R 483,363.07	R 483,363.07	R 483,363.07	R 483,363.07
Income											
Gross income	R 30,630.81	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20
Subsidy		R 180,000.00									
Working capital loan		R 309,848.12	R 309,848.12	R 232,386.09	R 154,924.06	R 154,924.06	R 154,924.06	R 154,924.06	R 154,924.06	R 154,924.06	R 154,924.06
Sub-total		R 1,102,464.32	R 922,464.32	R 845,002.29	R 767,540.26	R 767,540.26	R 767,540.26	R 767,540.26	R 767,540.26	R 767,540.26	R 767,540.26
Net income		R 211,694.79	R 31,694.79	R 40,990.23	R 50,285.68	R 50,285.68	R 284,177.19	R 284,177.19	R 284,177.19	R 284,177.19	R 284,177.19
Tax	15%	R 31,754.22	R 4,754.22	R 6,148.54	R 7,542.85	R 7,542.85	R 42,626.58	R 42,626.58	R 42,626.58	R 42,626.58	R 42,626.58
Net benefit of project		R 179,940.57	R 26,940.57	R 34,841.70	R 42,742.83	R 42,742.83	R 241,550.61	R 241,550.61	R 241,550.61	R 241,550.61	R 241,550.61
Return on investment		16.15%	2.42%	3.13%	3.84%	3.84%	21.69%	21.69%	21.69%	21.69%	21.69%
Average total net income per hectare		R 8,997.03	R 1,347.03	R 1,742.08	R 2,137.14	R 2,137.14	R 12,077.53	R 12,077.53	R 12,077.53	R 12,077.53	R 12,077.53
NPV	8%	R 1,685,012.58									

Item	Rate	Year									
		11	12	13	14	15	16	17	18	19	20
Area under irrigation		20	20	20	20	20	20	20	20	20	20
Expenses											
Production cost	R 14,023.89	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80	R 280,477.80
Machines, equipment & tools etc											
O&M of infrastructure		R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32	R 29,370.32
Infrastructure loan repayments	8%										
Working capital repayments	12%	R 173,514.95	R 173,514.95	R 173,514.95	R 173,514.95	R 173,514.95	R 173,514.95	R 173,514.95	R 173,514.95	R 173,514.95	R 173,514.95
Sub-total		R 483,363.07	R 483,363.07	R 483,363.07	R 483,363.07	R 483,363.07	R 483,363.07	R 483,363.07	R 483,363.07	R 483,363.07	R 483,363.07
Income											
Gross income	R 30,630.81	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20
Subsidy											
Working capital loan		R 154,924.06	R 154,924.06	R 154,924.06	R 154,924.06	R 154,924.06	R 154,924.06	R 154,924.06	R 154,924.06	R 154,924.06	R 154,924.06
Sub-total		R 767,540.26	R 767,540.26	R 767,540.26	R 767,540.26	R 767,540.26	R 767,540.26	R 767,540.26	R 767,540.26	R 767,540.26	R 767,540.26
Net income		R 284,177.19	R 284,177.19	R 284,177.19	R 284,177.19	R 284,177.19	R 284,177.19	R 284,177.19	R 284,177.19	R 284,177.19	R 284,177.19
Tax	15%	R 42,626.58	R 42,626.58	R 42,626.58	R 42,626.58	R 42,626.58	R 42,626.58	R 42,626.58	R 42,626.58	R 42,626.58	R 42,626.58
Net benefit of project		R 241,550.61	R 241,550.61	R 241,550.61	R 241,550.61	R 241,550.61	R 241,550.61	R 241,550.61	R 241,550.61	R 241,550.61	R 241,550.61
Return on investment		21.69%	21.69%	21.69%	21.69%	21.69%	21.69%	21.69%	21.69%	21.69%	21.69%
Average total net income per hectare		R 12,077.53	R 12,077.53	R 12,077.53	R 12,077.53	R 12,077.53	R 12,077.53	R 12,077.53	R 12,077.53	R 12,077.53	R 12,077.53
NPV	8%										

Financial Analysis

Scheme Kama Furrow
LOS Commercial-underutilised

Item	Rate	Year																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Area under irrigation		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Expenses																					
Production cost	R 13,435.29	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80	R 268,705.80
Machines, equipment & tools etc																					
O&M of infrastructure		R 120,591.60	R 120,591.60	R 120,591.60	R 120,591.60	R 120,591.60	R 120,591.60	R 120,591.60	R 120,591.60	R 120,591.60	R 120,591.60	R 120,591.60	R 120,591.60	R 120,591.60	R 120,591.60	R 120,591.60	R 120,591.60	R 120,591.60	R 120,591.60	R 120,591.60	R 120,591.60
Infrastructure loan repayments	8%	R 2,100,638.48	R 2,100,638.48	R 2,100,638.48	R 2,100,638.48	R 2,100,638.48															
Working capital repayments	12%	R 436,013.09	R 436,013.09	R 327,009.82	R 218,006.54	R 218,006.54	R 218,006.54	R 218,006.54	R 218,006.54	R 218,006.54	R 218,006.54	R 218,006.54	R 218,006.54	R 218,006.54	R 218,006.54	R 218,006.54	R 218,006.54	R 218,006.54	R 218,006.54	R 218,006.54	R 218,006.54
Sub-total		R 2,925,948.97	R 2,925,948.97	R 2,816,945.69	R 2,707,942.42	R 2,707,942.42	R 607,303.94	R 607,303.94	R 607,303.94	R 607,303.94	R 607,303.94	R 607,303.94	R 607,303.94	R 607,303.94	R 607,303.94	R 607,303.94	R 607,303.94	R 607,303.94	R 607,303.94	R 607,303.94	R 607,303.94
Income																					
Gross income	R 30,630.81	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20
Subsidy		R 371,000.00																			
Working capital loan		R 389,297.40	R 389,297.40	R 291,973.05	R 194,648.70	R 194,648.70	R 194,648.70	R 194,648.70	R 194,648.70	R 194,648.70	R 194,648.70	R 194,648.70	R 194,648.70	R 194,648.70	R 194,648.70	R 194,648.70	R 194,648.70	R 194,648.70	R 194,648.70	R 194,648.70	R 194,648.70
Sub-total		R 1,372,913.60	R 1,001,913.60	R 904,589.25	R 807,264.90	R 807,264.90	R 807,264.90	R 807,264.90	R 807,264.90	R 807,264.90	R 807,264.90	R 807,264.90	R 807,264.90	R 807,264.90	R 807,264.90	R 807,264.90	R 807,264.90	R 807,264.90	R 807,264.90	R 807,264.90	R 807,264.90
Net income		-R 1,553,035.37	-R 1,924,035.37	-R 1,912,356.44	-R 1,900,677.52	-R 1,900,677.52	R 199,960.96	R 199,960.96	R 199,960.96	R 199,960.96	R 199,960.96	R 199,960.96	R 199,960.96	R 199,960.96	R 199,960.96	R 199,960.96	R 199,960.96	R 199,960.96	R 199,960.96	R 199,960.96	R 199,960.96
Tax	15%	R 0.00	R 0.00	R 0.00	R 0.00	R 0.00	R 29,994.14	R 29,994.14	R 29,994.14	R 29,994.14	R 29,994.14	R 29,994.14	R 29,994.14	R 29,994.14	R 29,994.14	R 29,994.14	R 29,994.14	R 29,994.14	R 29,994.14	R 29,994.14	R 29,994.14
Net benefit of project		-R 1,553,035.37	-R 1,924,035.37	-R 1,912,356.44	-R 1,900,677.52	-R 1,900,677.52	R 169,966.81	R 169,966.81	R 169,966.81	R 169,966.81	R 169,966.81	R 169,966.81	R 169,966.81	R 169,966.81	R 169,966.81	R 169,966.81	R 169,966.81	R 169,966.81	R 169,966.81	R 169,966.81	R 169,966.81
Return on investment		-17.73%	-21.97%	-21.83%	-21.70%	-21.70%	1.94%	1.94%	1.94%	1.94%	1.94%	1.94%	1.94%	1.94%	1.94%	1.94%	1.94%	1.94%	1.94%	1.94%	1.94%
Average total net income per hectare		-R 77,651.77	-R 96,201.77	-R 95,617.82	-R 95,033.88	-R 95,033.88	R 8,498.34	R 8,498.34	R 8,498.34	R 8,498.34	R 8,498.34	R 8,498.34	R 8,498.34	R 8,498.34	R 8,498.34	R 8,498.34	R 8,498.34	R 8,498.34	R 8,498.34	R 8,498.34	R 8,498.34
NPV	8%	-R 6,306,129.00																			

Financial Analysis

Scheme Mantusini
LOS Commercial-underutilised

Item	Rate	Year																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Area under irrigation		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Expenses																					
Production cost	R 14,482.89	R 289,657.80	R 289,657.80	R 289,657.80	R 289,657.80	R 289,657.80	R 289,657.80	R 289,657.80	R 289,657.80	R 289,657.80	R 289,657.80	R 289,657.80	R 289,657.80	R 289,657.80	R 289,657.80	R 289,657.80	R 289,657.80	R 289,657.80	R 289,657.80	R 289,657.80	R 289,657.80
Machines, equipment & tools etc		R 0.00																			
O&M of infrastructure		R 20,155.78	R 20,155.78	R 20,155.78	R 20,155.78	R 20,155.78	R 20,155.78	R 20,155.78	R 20,155.78	R 20,155.78	R 20,155.78	R 20,155.78	R 20,155.78	R 20,155.78	R 20,155.78	R 20,155.78	R 20,155.78	R 20,155.78	R 20,155.78	R 20,155.78	R 20,155.78
Infrastructure loan repayments	8%	R 556,715.18	R 556,715.18	R 556,715.18	R 556,715.18	R 556,715.18															
Working capital repayments	12%	R 346,991.21	R 346,991.21	R 260,243.41	R 173,495.60	R 173,495.60	R 173,495.60	R 173,495.60	R 173,495.60	R 173,495.60	R 173,495.60	R 173,495.60	R 173,495.60	R 173,495.60	R 173,495.60	R 173,495.60	R 173,495.60	R 173,495.60	R 173,495.60	R 173,495.60	R 173,495.60
Sub-total		R 1,213,519.97	R 1,213,519.97	R 1,126,772.16	R 1,040,024.36	R 1,040,024.36	R 483,309.18	R 483,309.18	R 483,309.18	R 483,309.18	R 483,309.18	R 483,309.18	R 483,309.18	R 483,309.18	R 483,309.18	R 483,309.18	R 483,309.18	R 483,309.18	R 483,309.18	R 483,309.18	R 483,309.18
Income																					
Gross income	R 30,630.81	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20	R 612,616.20
Subsidy		R 300,000.00																			
Working capital loan		R 309,813.58	R 309,813.58	R 232,360.19	R 154,906.79	R 154,906.79	R 154,906.79	R 154,906.79	R 154,906.79	R 154,906.79	R 154,906.79	R 154,906.79	R 154,906.79	R 154,906.79	R 154,906.79	R 154,906.79	R 154,906.79	R 154,906.79	R 154,906.79	R 154,906.79	R 154,906.79
Sub-total		R 1,222,429.78	R 922,429.78	R 844,976.39	R 767,522.99	R 767,522.99	R 767,522.99	R 767,522.99	R 767,522.99	R 767,522.99	R 767,522.99	R 767,522.99	R 767,522.99	R 767,522.99	R 767,522.99	R 767,522.99	R 767,522.99	R 767,522.99	R 767,522.99	R 767,522.99	R 767,522.99
Net income		R 8,909.81	-R 291,090.19	-R 281,795.78	-R 272,501.37	-R 272,501.37	R 284,213.81	R 284,213.81	R 284,213.81	R 284,213.81	R 284,213.81	R 284,213.81	R 284,213.81	R 284,213.81	R 284,213.81	R 284,213.81	R 284,213.81	R 284,213.81	R 284,213.81	R 284,213.81	R 284,213.81
Tax	15%	R 1,336.47	R 0.00	R 0.00	R 0.00	R 0.00	R 42,632.07	R 42,632.07	R 42,632.07	R 42,632.07	R 42,632.07	R 42,632.07	R 42,632.07	R 42,632.07	R 42,632.07	R 42,632.07	R 42,632.07	R 42,632.07	R 42,632.07	R 42,632.07	R 42,632.07
Net benefit of project		R 7,573.34	-R 291,090.19	-R 281,795.78	-R 272,501.37	-R 272,501.37	R 241,581.73	R 241,581.73	R 241,581.73	R 241,581.73	R 241,581.73	R 241,581.73	R 241,581.73	R 241,581.73	R 241,581.73	R 241,581.73	R 241,581.73	R 241,581.73	R 241,581.73	R 241,581.73	R 241,581.73
Return on investment		0.30%	-11.54%	-11.17%	-10.80%	-10.80%	9.58%	9.58%	9.58%	9.58%	9.58%	9.58%	9.58%	9.58%	9.58%	9.58%	9.58%	9.58%	9.58%	9.58%	9.58%
Average total net income per hectare		R 378.67	-R 14,554.51	-R 14,089.79	-R 13,625.07	-R 13,625.07	R 12,079.09	R 12,079.09	R 12,079.09	R 12,079.09	R 12,079.09	R 12,079.09	R 12,079.09	R 12,079.09	R 12,079.09	R 12,079.09	R 12,079.09	R 12,079.09	R 12,079.09	R 12,079.09	R 12,079.09
NPV	8%	R 555,313.63																			